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## DEVELOPMENT COUNCILS IN INDUSTRY

THE anticipated Bill to give effect to the recommendations of the reports of the 'working parties' set up by the Board of Trade, and particularly to provide for the use of a compulsory levy to support scientific research, has now been published and received its second reading in the House of Commons on February 13. The debate on this Industrial Organisation Bill, however, scarcely touched on the issues which are disturbing to those most closely concerned with research, and it is to be hoped that its clauses will receive much more searching and constructive criticism when the Bill reaches the House of Lords. In spite of the fact that all the reports so far received from the 'working parties' have favoured a compulsory levy, it is by no means certain, as Mr. I. J. Pitman and Mr. W. Shepherd pointed out in the House of Commons, that duress will prove more effective than persuasion for the purpose in mind.

The Bill enables any of the ministers specified in the Bill, including the President of the Board of Trade, and the Ministers of Agriculture and Fisheries, Supply, Food, and Fuel and Power, after consultation with organisations of workers and employers in an industry, to establish a development council for that industry. The general objects of such councils are to increase the efficiency and productivity of the industry concerned, and to enable it to render better and more economical service to the community. For this purpose a development council may be authorized to promote or undertake scientific research or research into industrial psychology, the incidence, prevention and cure of industrial disease, the marketing of products, or the consumption or use of goods and services supplied by the industry. A council may also be empowered to promote inquiry into materials and equipment, methods of production, management and the utilization of labour, the improvement of design, the production and marketing of standard products, the training of personnel and improvement of working conditions as well as the collection and formulation of statistics. A council may also be authorized to collect a levy to finance its activities, the maximum rate of such levy being laid down in the order establishing the council. These orders must be first approved in draft by both Houses of Parliament, and the main features of the constitution of the councils are determined in the Bill, which provides for the appointment of their members by the minister concerned, and that they shall consist of persons capable of representing the interests of employers and workers in the industry, with independent persons, one of whom will be appointed chairman by the minister. There are rigid restrictions on the disclosure by members of a council, or its officials, of information relating to individual businesses, and a further clause empowers the minister concerned to collect a levy from an industry for which no development council exists, if he considers it necessary that finance should be made available for the promotion of

scientific research, the development of exports or the improvement of design in that industry. The Board of Trade is also empowered to make grants to the Council of Industrial Design or to any other non-profit-making body the objects of which include the improvement of design in industry.

In moving the second reading, the President of the Board of Trade stressed the importance of flexibility in applying any pattern of organisation, and did not suggest that it would be desirable to deal with every industry under the Bill. But while he was careful to avoid any suggestion that the work of the joint industrial councils should be disturbed, and insisted that production and development matters should be kept separate from negotiations as to wages and conditions of work, the first criticism that will be made, apart from the question of the validity of compulsion, by the scientific worker at least, is that the activities of the development councils may overlap seriously within their own ranks and with one another. That criticism was indeed advanced in the debate by Mr. Mikardo and by Mr. Mallalieu. Admittedly, many of the functions scheduled in the Bill are appropriate for co-operative effort and even demand it. The question is rather whether that effort should not be made on an even wider basis than the limits of a single industry.

That very clearly may be true of such matters as industrial psychology, where it might be thought that to develop the work of the National Institute of Industrial Psychology is the appropriate means to adopt. Again, as regards industrial health and disease, it might equally be argued that further support should be first extended to the Industrial Health Research Board, while as regards management and training there is much to be said for encouraging the work of the Institute of Industrial Administration or the new British Institute of Management, rather than fostering new and unrelated sectional activities in the same field. Mr. Mallalieu and Wing-Commander Shackleton in particular were concerned with the danger of dissipating effort here, and the former also observed that the improvement of working conditions, even the 'spring-cleaning programme' advocated by the Chief Inspector of Factories in his last report, is essentially a matter for Government assistance with priorities in materials and labour. On the question of research, the Bill encourages no more confidence than the reports of the 'working parties' themselves, several of which have shown a most inadequate appreciation of the nature of research and the conditions for its effective prosecution.

That point indeed did not entirely escape notice in the debate. Mr. Rhodes asked specifically how the Bill was related to the grants from the Department of Scientific and Industrial Research and also to the grants from the Council of Industrial Design. Mr. Belcher, replying for the Government, stated that development councils would work through, and would not supersede, research associations and design centres. Contributions to these bodies from a development council's research levies would count as industrial contributions and would be eligible for the appropriate Government grants from the Department of Scientific and Industrial Research in regard to research and from the Board of Trade in regard to design. Sir Stafford Cripps had also earlier disclaimed any idea of compulsion in regard to research. Here a development council could help and advise; but its compulsory powers, when granted, were to be limited to the collection of statistics, the registration of persons in industry and the collection of a levy.

Sir Stafford Cripps was more concerned with the danger that the councils might be liable to try to adopt and encourage restrictive practices, which would be inimical to the consumer and to the general national welfare. That danger may be inherent in bodies the members of which are representative of an industry, rather than chosen with a view to the fitness of the individual member for the job to be done. Although Sir Stafford indicated the Government's intention to take active steps to stop the encouragement of restrictive practices by a development council, that is not an easy task in practice, nor is there any certainty that other Governments would be equally concerned to try. Moreover, there is an equally serious danger to which Mr. Pitman referred in the able speech already noted, namely, that of industry tending to shuffle the responsibility for dealing with its problems on to the development councils.

Such a tendency can be seen in the trend of some of the reports from the 'working parties', and it is well illustrated by the coal industry at the moment. Something of the acuteness of the fuel crisis might well have been mitigated had, for example, more note been taken of such reports as that on "Coal Utilisation Research and the National Economy" which the Parliamentary and Scientific Committee forwarded to the Lord President of the Council in May 1943. It was left to Lord Marley to direct attention to this factor in the debate on the coal situation in the House of Lords on February 13. Referring to the inefficient utilization of coal and the waste of coal resources by industry, Lord Marley cited not only the work of the British Coal Utilisation Research Association, the British Colliery Owners' Research Association, the Gas Research Board, the Fuel Research Station and other stations of the Department of Scientific and Industrial Research, but also an important report in 1943 from the Select Committee on National Expenditure; from all these sources many recommendations had been made for the saving of coal in the production of power and heating of buildings and plant, but industry had neglected them. This picture of twenty years of neglect of available knowledge and wasted national assets should give pause to any elaborate proposals for development from outside. The results of research will only be utilized when management, particularly in the smaller firms, becomes research-minded, and that change of outlook will often of itself induce the undertaking of research by such firms.

The prosecution and utilization of research by industry depend fundamentally, as we have so often

urged, upon having men with the scientific outlook and training on the boards of management and directors, and there is no short cut which can wisely be taken to avoid the slow task of education and persuasion. It is not easy at first sight to see what more the development councils could contribute here that existing organisations could not already supply. It is true that they may do good in different directions; on the other hand, they may do little to justify their cost and may still discourage private initiative. Any element of compulsion in relation to research is to be distrusted on *a priori* grounds, and only used as a last resort. Where persuasion by other means is possible it should be tried, and such opportunities of indirect stimulus to research as we once had under the Import Duties Advisory Committee should not again be missed.

Everything, in fact, will depend on the membership and staff of any development councils, and the extent to which the idea, not of sectional represention of one side of an industry or another, or of one set of private interests rather than another, but of the welfare of the industry as a whole and of the service of the community, sets the standard for their policy and administration. It is a question of men rather than of organisation, and in setting up such councils the Government will do well to press forward by every means in its power those developments such as the British Institute of Management which promise to increase the supply of trained administrators and managers, qualified to appreciate and assess advances in science and to apply them to the purposes of the industry in which they are engaged. None the less, it is important that the organisation which the Bill proposes to establish should be subjected to a most careful scrutiny, such as Mr. Pitman also suggested, to determine how far it is in keeping with the cardinal principles of organisation on which any such scheme must be based. Mr. Pitman indeed, from his experience as director of the Organisation and Methods Division of the Treasury, believes that departure from the voluntary principle is a fatal defect in a body in which the co-operation of employers, management and workers is involved; and the danger of an overlap of functions and responsibility which was stressed from both sides of the House in the debate indicates the need for a close examination of such relations, for clearer definition of functions as between the industries and various national functional bodies. What is certain is that failure to serve sound administrative principles in the organisation of the councils and in defining their functions will be a fatal obstacle in attracting to their service the first-class men who are indispensable to the success of the whole scheme. Whether or not the development councils can do anything that the joint industrial councils could not equally well foster, it appears essential that their compulsory powers should be used both with restraint and discretion. It is equally important that care should be taken to see that they involve no further dissipation or waste of our precious resources of trained manpower, either in the scientific or in the technical field.

# PRE-NATAL PHYSIOLOGY

## Researches on Pre-Natal Life

By Sir Joseph Barcroft. Vol. 1. Pp. xiii + 292. (Oxford: Blackwell Scientific Publications, Ltd., 1946.) 37*s*. 6*d*. net.

THIS book is the first of its kind; it may be described as a work on physiological ontogeny: that is to say, it deals with the development of function in the progress of fœtal life. Moreover, it keeps in view throughout, not only the intra-uterine conditions under which the fœtus lives and grows, but the fact that the fœtus will eventually pass out into the world and in such a state that it can respond successfully to its new environment. The book deals mainly with investigations by the author himself and his colleagues and pupils in the Schools of Physiology and Agriculture in Cambridge. It does not claim to be a text-book on the subject, and so does not include such work as has been done in other centres like that on the initiation of the heart beat carried out at the Johns Hopkins University. Nevertheless, it covers very considerable ground, and the relevant papers by other investigators are duly quoted. The researches were mostly upon the fœtal sheep, and it is impossible to refrain from an expression of admiration for the ingenuity of the investigator and for the results which he obtained, especially when one bears in mind the great difficulty that must have been experienced in dissecting fœtal lambs so as to preserve any considerable degree of normality. Wherever possible the author has correlated his observations and those of others so as to give a connected story of the physiological events studied. But he very wisely does not always attempt this, and at the beginning of the chapter on the oxygen capacity, he says frankly that he decided to record a series of unconnected observations rather than to arrange them under some hypothetical scheme. For here, as in other parts of the book, the facts are not only interesting but also beautiful in themselves, and need no scientific hypothesis to make them more so.

The first two chapters are on the disposition of vessels in the placenta and the crossing of the placental barrier, and the author begins with a comparison between placental and fœtal growth in the sheep; and it is shown that whereas the fœtus puts on weight every week, the cotyledons of the uterus, after reaching a maximum at about ninety-five days, proceed to decline. It is not clear how much the maternal growth during pregnancy depends upon the fœtus, and it is known that some uterine development (at least in certain species) occurs after ovulation in the absence of a fœtus. With regard to the matter of permeability the author finds that, contrary to the views of Flexner, the greater the number of layers in the fœtal barrier, the more perfect is the fœtus at birth, and he instances the horse with a six-layer placenta, quoting an experience of Hammond, who found that a newly born foal was so perfect at birth that it ran away promptly and could not at first be caught. The author emphasizes that though the several types of placenta differ much, they all serve their purpose in their own way, but that the great surface which among other varying devices promotes the passage of material across the fœtal membrane is present in all forms of placenta. The passage of oxygen from the mother to the fœtus is simply one of diffusion, as Huggett and others have

concluded. It is shown, further, that fatty food substances vary with the maternal ones, but that sugar in sheep and goats is present in greater quantity in the fœtal blood than in the maternal. The author quotes experiments by Passmore and Schlossmann showing that by injecting glucose into the mother the glucose content of the fœtal blood can be raised. The deduction seems clear, both in the case of fats and sugars, that by altering the diet of the mother the food contents of the fœtus may also be modified, and this is a conclusion of great practical importance for breeders of farm animals.

The next chapters, on growth, contain interesting comparative studies, and Hammond's observations on the pig are quoted, showing that embryos perish *in utero* and at varying stages of development, and that this is not usually due to overcrowding, for it may occur in any part of the uterus. The work of Wallace and that of Carlyle is referred to, showing that the various organs of the fœtus undergo their maximal development at different times; even within the same organ (for example, the gut) the different parts have their critical periods of growth, and bones develop at different rates. At birth, blood is one of the four bodily constituents of major weight, the other three being skin, skeleton and muscle. The last three or four weeks of pregnancy are the great blood-forming period. The question arises as to whether, at specific times during gestation, special foods should not be fed to the mother. This question, together with the more general one of the relations between maternal nutrition and fœtal development, is dealt with again in Chapter 5, which concludes by remarking on the special importance of this subject in the present age when the possibility of semi-starvation is confronting a large part of the world. The author quotes Hammond, who has shown in his experiments on pigs and rabbits that the larger and better nourished the mother the larger are the young; and Wallace has proved quite definitely for the sheep that by altering the diet of the mother one can influence the growth of the offspring. Nevertheless, the fœtuses may have their own intrinsic growth mechanisms which vary from individual to individual.

The seventh chapter is upon the transfer of blood from the placenta to the fœtus at birth, and numerous experiments involving the tying or clamping of the umbilical cord are described. It is shown that the average amount of blood transferred was 120 c.c. or 39 c.c. per kilo, which is not very different from that found in man. The presumption is that the blood is expelled as a result of the umbilical and placental vessels contracting.

The water content of the fœtal tissues is next dealt with, and then the basal consumption of oxygen of the tissues of the sheep fœtus at different ages. The cardiac output is the subject of the tenth chapter, and it is shown that this is much greater towards the end of pregnancy.

The following chapters are on blood pressure and the development of vascular reflexes, and in reading the accounts of the several experiments one is impressed by the difficulties involved but successfully overcome in applying a difficult technique. That there should be great variability in the different species was to be expected in view of the varying degrees of development at birth. Among other interesting points, it is shown that the venous pressures do not rise like the arterial ones, but remain fairly constant after the fiftieth day. Slowing of the heart beat by vagus stimulation could occur on the seventy-seventh day in the sheep. The pulse-rate was found to become progressively slower after the ninety-third day. In the chapter on the oxygen dissociation curve the subject is complicated by the fact that there are two sorts of hæmoglobin, the myohæmoglobin of muscle and that found in normal blood. In the earlier stages of fœtal life hæmoglobin is made very largely in the liver, and this may give rise to myohæmoglobin.

In the chapter on acid-base equilibrium and carbon dioxide dissociation curves the work of Huggett and Keys is dealt with, and it is shown that the carbon dioxide pressure is almost certainly higher in the fœtal than in the maternal blood, and that the hydrogen ion concentration of the fœtal blood is less than that of the maternal. Further, Keys found that the dissociation curve of a pregnant goat was below that of the control, but the fœtal dissociation curve as compared with that of the mother might be either above or below. In the chapter on the oxygen in the umbilical vessels the fact emerges that while all other factors fluctuate widely the oxygen content in the umbilical vein is almost constant. The author comments on the similarity between the oxygen content of the blood in the umbilical artery and that in the thoracic vena cava. Later, he gives the evidence that there is a sphincter at the umbilical end of the ductus venosus which contracts after delivery. Another point of interest is that the foramen ovale is not 'just a hole', for as shown by Barron and by Franklin, it constricts with each heart beat. In the nineteenth chapter the author shows that the view taken by Wolff a hundred and fifty years ago, that the streams of blood which reach the right side of the fœtal heart do not completely mix, is correct. Kennedy and Clark are quoted as demonstrating that oxygen, and not just any gas, causes the closure of the ductus arteriosus, and that this does not result from nervous stimulation.

Chapter 21 is on the respiratory process, and it is shown that this is very efficient for the fœtus, at least up to the 120th day, since the vascular bed in the placenta is large. Later, the conditions deteriorate as the end of pregnancy draws near, and "the fœtus is approaching a crisis . . . the alternative between death and escape". The last chapter deals with the onset of respiratory movement, and the author describes how at halfway through gestation in the sheep the fœtus, after having been temporarily inert, is already capable of making normal respiratory movements as a result of occluding the umbilical cord, though it cannot breathe if only because the lung is solid.

The high degree of perfection to which the fœtus has attained in co-ordinating its functional activities in the progress of growth and development must be a matter of constant wonder to the investigator, and one is reminded of the words of Samuel Butler: "Birth is the end of the time when we really knew our business, and the beginning of the days when we know not what we would do, or do".

The volume is dedicated to D. H. Barron, with whom the author collaborated in so many of his researches. In a brief notice such as this only a very few of the observations recorded have been quoted, and it has been difficult to make a selection. The book needs to be read in order that its scope may be realized and its originality appreciated. It is to be followed by a second volume dealing with the nervous system and the principles of metabolism.

F. H. A. Marshall

# AGRICULTURAL BOTANY

## Principles of Agricultural Botany

By Dr. Alexander Nelson. Pp. xvii+556+128 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1946.) 35*s*. net.

THE publication of a new text-book of agricultural botany is something of an event, since only one has been available hitherto. This paucity is due to two main reasons. First, agricultural botany scarcely exists as a unitary subject in the United States and most other countries, its content being subdivided and variously allocated. Secondly, the need for a text-book has previously been met by Percival's "Agricultural Botany", which has run into eight editions and been translated into various languages. This book, first published in 1900, was a remarkable pioneer work which appeared in its last edition only ten years ago. But, during the past three decades, the approach to the subject of agricultural botany has changed, the content of the subject has expanded and acquired new orientations, and the outlook of agricultural botanists has developed in relation to advances in 'pure' science and in agricultural science and practice. Percival's book, valuable as it is and in many ways still indispensable, has changed but little in its successive editions, and there is need of a treatise reflecting the modern state of agricultural botany that will serve teachers and students to-day as well as Percival's volume served those of earlier years. Nelson's "Principles of Agricultural Botany" must be viewed against this background.

One is, perhaps, a little disturbed by the title of the book. Agricultural botany is not an autonomous science; it is merely the diffused area of scientific knowledge which forms the meeting-ground of botany with various other sciences and empirical practices. Its content and boundaries are determined by the sole criterion that the plants with which it deals are, in their crop husbandry relationships, useful or harmful to man. The principles involved in its study are principles of botany and certain cognate sciences, not of agricultural botany.

The book is organised in four sections: morphology and anatomy; physiology; negative factors in food production; and heredity, evolution and classification. Section 1 opens with a chapter on "Food in General" which might better have been placed in section 2. The author then discusses the elements of plant form and structure, which leads to an exposition of the modifications of 'standard type' seen in agricultural plants. A discussion of the elements of plant reproduction similarly leads to a detailed consideration of the special aspects of the inflorescence, flower, fruit and seed of these plants. The student thus proceeds from certain general principles of botany to special examples chosen from agricultural botany, and, by the end of section 1, has acquired a considerable amount of information concerning crop plants. In section 2, principles and technical data are more closely interwoven. Much modern physiological research of a fundamental nature has been carried out on economic plants, and the author can thus illustrate his exposition of principles by direct reference to crop plants and agricultural conditions. There is, however, the same general trend from principles to special information, the introductory chapter, which some agricultural students may not survive, dealing with abstruse "Fundamental Concepts", while the section closes with a purely technical chapter on "Pasture". Section 3, in both contents and text, is headed "Weeds; Insect Pests; Disease", but the four chapters give a brief account only of weed biology and control and of diseases caused by environmental factors, viruses, fungi and bacteria. The student is again introduced to certain relevant principles; but he acquires little of the technical knowledge of these subjects expected of a well-trained agricultural botanist. Section 4, on "Heredity, Evolution and Classification", contains only two chapters, which give a still briefer and less adequate account of these subjects.

Thus, the general balance of the book cannot be regarded as satisfactory and, in view of the fundamental importance in agriculture of the subject-matter of sections 3 and 4, the author's admission in his preface that "it may appear that some subjects have received rather cavalier treatment" would seem more correct than his claim that "Nevertheless, matters of botanical interest significant in agriculture have received adequate treatment". Further, the author's discussion of his subject-matter is very unequal, section 1 being written at about agricultural college level, section 2 at about university level, and the last two sections at about farm institute level. Certainly, from my experience of examining in various universities, the book does not substantiate the author's claim that it assembles "all the information likely to be required by you when preparing for a formal examination in Botany, leading to a degree or diploma in Agriculture". Moreover, although, on the whole, the text is simple and straightforward, there are many awkward sentences, some statements that are ambiguous or dubious, others that are positive misstatements and, occasionally, some serious errors. Further, in many respects, the author's treatment of his material is not up to date.

One of the most disturbing features of the book is the author's adoption throughout of vernacular names of plants, scientific names being virtually absent. This, in spite of the fact that he recognizes that "Unfortunately, these 'common' names differ in different districts or areas. . . . A name universally used for the same species all the world over is required. Science is international, and scientists must be able to write and speak about a plant so that scientists everywhere can understand just what particular plant is meant." In these days, when even school-children and growers are becoming familiar with the scientific names of plants and appreciative of the reasons for their usage, Dr. Nelson's practice seems incomprehensible. Each chapter closes with a short list of books for further reading and, apart from misspelling of authors' names and errors in citation, these lists are often unsatisfactory.

The format of the book is almost that of an 'edition de luxe', and it contains 182 text-figures, 128 half-tone plates and 17 plates in colour. Many of these illustrations are original and most of them are of high quality, although there are some bad lapses, and one can understand the author's grateful acknowledgment to his publishers "whose enthusiasm has made the book possible". On the other hand, the sumptuous format, practically all the coloured illustrations, very many of the half-tone plates and many of the text-figures are entirely unnecessary, and a more restrained enthusiasm might have produced an equally useful book at a much lower price. Most agricultural students will look several times before

paying thirty-five shillings for a text-book that covers inadequately only a portion of their course in agricultural botany. The author had a great opportunity, and one can only regret that he has not made the best use of it. W. B. BRIERLEY

## PHILIPPINE BIRDS

**Birds of the Philippines**

By Jean Delacour and Ernst Mayr. (Pacific World Series.) Pp. xv + 309. (New York: The Macmillan Company, 1946.) 18*s*. net.

IN a foreword to this volume, Prof. Fairfield Osborn explains that it is one of a series brought out under the auspices of the American Committee for International Protection of Wild Life. The object of this series, which deals with all branches of animal life and plants, is to make known to the public "the wonder and beauty of natural things" and create a desire to protect and conserve the fauna and flora of the islands of the Pacific and neighbouring lands. Much of the pioneer work on the avifauna of the Philippines was done by two famous English collectors, A. H. Everitt and John Whitehead, and the Marquis of Tweeddale made the birds of these islands his special study. Macgregor's "Manual" was for long the standard authority, and some eleven years ago Hachisuka commenced an ambitious work, of which not more than five parts appeared—but like all that writer's work it is a mere compilation.

This volume now brings our knowledge up to date in a very condensed form and is a valuable addition to the ornithological literature of the area. It is unfortunate, however, that more space has not been devoted to the habits and biology of the different species, which are of more interest to the general reader than the details of subspecies. Then, too, in the chapter on the bird geography of the islands the entire absence of English names is apt to be rather disconcerting to the general reader. To the student of geographical variation the book supplies much useful information, and nowhere can this subject be better studied than in the Philippine Islands. Take, for example, the striking crimson-backed woodpecker, *Chrysocolaptes lucidus*, of which there are no fewer than six well-defined races differing in colour.

These islands are the home of the magnificent monkey-eating eagle, *Pithecophaga jefferyi*, first discovered by John Whitehead. They are specially rich in pigeons, cuckoos and kingfishers, the last ranging from the rather ungainly stork-billed kingfisher to the brilliantly coloured woodland species barely five inches in length. The Philippines are considered a sub-region of the Oriental region; but a part of the Archipelago, the Palawan group, belongs to the Malaysian sub-region. The birds of this group are treated in a separate appendix, and one of the most striking is the Palawan peacock pheasant, *Polyplectron emphanum*, which belongs to a genus not represented in the Philippines proper but ranging from Borneo to the Eastern Himalayas.

The authors have considered it necessary to suppress some well-known genera. They do not recognize the genus *Squatarola* and treat it as a synonym of *Pluvialis*, since they do not think the absence of the hind-toe in the grey plover is sufficient to place it in a separate genus from the golden plover. Had they studied Lowe's papers they would have learnt there are other differences which make a good case for keeping the two genera. It is unfortunate, too, that many well-established English names have been changed because the authors consider them unsuitable. Among others the common kingfisher becomes the river kingfisher, Swinhoe's snipe the marsh snipe, and the black-necked tailor-bird the common tailor-bird. All rather confusing for the amateur ornithologist who visits different parts of the East. N. B. KINNEAR

## A RUSSIAN REVIEW OF BONDS IN CHEMISTRY

**The Chemical Bond and the Structure of Molecules**

(In Russian.) By Ya. K. Syrkin and M. E. Dyatkina. Pp. 588. (Moscow and Leningrad: State Scientific-Technical Publishing House of Chemical Literature, 1946.) 30 roubles.

THE authors of this work, who in recent years have been making important contributions to the study of resonance, the diradical state, polarity in the hydrocarbon series, and the structure of the boron hydrides, are probably the best-known Russian workers in the field of quantum chemistry. The book is intended to fill the gap which has apparently existed in Russian chemical literature by reason of the absence of books comparable with the standard British and American treatises on the theory of the chemical bond and wave-mechanical conceptions of valency. It covers broadly the ground of Pauling's "Nature of the Chemical Bond", but in addition presents the mathematical foundations of quantum mechanics (Schrödinger's method), the detailed Heitler–London treatment of molecules, and the mathematical point of view in general; for the authors consider that the student can achieve the critical attitude essential for progress in this field only by becoming thoroughly acquainted with all the postulates, limitations and approximations involved in the deduction of the equations which he will use.

After a description of the principles of the electronic configurations of atoms, which includes an introduction to the conception of wave functions, there follows a wave-mechanical study of the hydrogen molecule ion, the hydrogen molecule, and the homopolar bond. The subjects of directed valency bonds, resonance, the method of molecular orbitals, infra-red and Raman spectra, dipole moments, bond energies, intermolecular forces, the crystalline state, complex compounds, and the structure of the boron hydrides are presented against a background of experimental data, and controversial matters are critically discussed. Quite recent work is reviewed; for example, Longuet-Higgins and Bell on $B_2H_6$ (*Proc. Roy. Soc.*, A, **183**, 357; 1945).

The last three chapters (pp. 480–569) are entirely mathematical and deal with the three-electron problem (Slater's method), the calculation of resonance energy, and miscellaneous problems.

There are author, formulæ and subject indexes. The book appears to be more comprehensive and up to date than any single volume on the chemical bond at present available in the English language.

G. STANLEY SMITH

## The Milky Way

By Bart J. Bok and Priscilla F. Bok. (Harvard Books on Astronomy.) Second edition. Pp. vi+224. (London: J. and A. Churchill, Ltd., 1946.) 18*s*.

WRITERS on astronomical subjects find it comparatively easy to give a popular or semi-popular description of such a parochial affair as the solar system, but not so easy to provide a similar description of the Galaxy. The book under notice is undoubtedly the best of the semi-popular type that has been produced on this subject, and it presents the reader with an excellent account of the methods used to explore the Milky Way and to fathom some of its secrets. Here we have descriptions of the means by which astronomers ascertain stellar distances, masses, sizes, temperatures, etc., and most of these can be easily understood by those who have little or no background in mathematics or physics. They will read the interesting story of our Galaxy—just one of millions—the longest axis of which is more than 100 million light-years, the number of stars probably exceeding 100,000 million. Some of these stars are so large that the sun could be placed at the centre, and the orbit of Mars would lie well inside their outer layers, while the whole system is moving around its centre, the speed of the sun being 150 miles a second and the time required to complete a revolution 200 million years.

It must not be assumed that all the secrets of the Milky Way have been laid bare; so much still remains to be done that it would be true to say that our knowledge of the Galaxy as well as of the extra-galactic systems is very limited, and many years of patient research will be necessary before it is possible to settle a number of controversial points. Readers of this book will probably form the opinion that far more remains to be done than has yet been accomplished.

The work is illustrated with ninety-three figures, two of which are large-scale photographic maps of the Milky Way and thirty of celebrated astronomers whose investigations have been responsible for advancing our knowledge of the Galaxy.

M. DAVIDSON

## Field Archæology

By R. J. C. Atkinson. Pp. x+238+8 plates. (London: Methuen and Co., Ltd., 1946.) 12*s*. 6*d*. net.

IT is all to the credit of British archæology that its technique of field-work and excavation should have been built far less from theoretical principles than from practical experience, won gradually in the field itself by the men and women on the job. But matters have latterly been coming to a point where the fruits of this experience required gathering together, for the benefit both of beginners and indeed of the men and women on the job themselves. Mr. Atkinson's book meets this requirement admirably. A little more than two hundred pages long and of convenient pocket size, it is exactly suited to the part of archæologist's 'companion', in which it should be assured of a long career of usefulness and many editions.

The author is still young, but he writes throughout from personal knowledge of what he is discussing, gained mainly in the region of Oxford, where he is now assistant keeper of antiquities in the Ashmolean Museum. True, workers in the regions of sterner physique in the north and the farther west may here and there have things to add; but the book abounds so richly in practical information and quietly shrewd advice that it is really indispensable for anyone pursuing out-of-door archæology, no matter where, nor whether professionally or as a constant or occasional hobby. Field-work and excavation, surveying, recording and photography, interpretation of evidence and the preparing of reports for publication are all treated thoroughly yet simply, and the plates and the author's diagrams are altogether excellent.

C. F. C. HAWKES

## Plastics Applied

Being a Survey of Patent and Technical Literature with Collected Data of Interest to Users of Plastics in all Branches of Industry. Edited by Dr. V. E. Yarsley. Second edition. Pp. 528+lvi+8 plates. (London: National Trade Press, Ltd., 1946.) 42*s*. net.

THIS handsome volume represents the present stage in the development of plastics in so far as applications are concerned. Naturally, therefore, one would not expect to find a great deal relating to fundamental research. After an introductory review, a good account of the numerous uses of plastics in industry follows. Indeed the range is amazing: shipbuilding, photography, textiles, insulation, to mention but a few of the actual or potential uses. There are two chapters on welfare and safety problems, which will be welcome, and, at the end, a number of useful tables.

Two points of wide interest may be singled out; one is that with so much replacement to do in all branches of national life, the opportunity (and responsibility) for good design should be fully realized by manufacturers; the other stresses the manifold possibilities which occur in starting with substances almost universally colourless. The implication is that almost every conceivable hue should be within the grasp of designers and artists.

The compilers have managed to produce a book obviously suitable for consultation in the office and factory which is, at the same time, dignified and appropriate as a work of reference. F. I. G. R.

## A Bibliography of Statistical Quality Control

By Grant I. Butterbaugh. (Published for the Bureau of Business Research of the College of Economics and Business.) Pp. viii+114. (Seattle, Wash.: University of Washington Press, 1946.) 1.50 dollars.

STATISTICAL methods of controlling quality of output have now been tried out in many branches of industry, the War in particular having provided a strong impetus with its demand for large-scale fine-quality production. The literature of the subject has become bulky, and contains records of interesting ideas and extensive practical experience (together with, unfortunately, much wearisome repetition of the same first principles). This bibliography covers literature published up to 1945. Most of the entries are followed by a brief synopsis or a reference to published reviews. The compilation has been made carefully, and will be of service to many "statisticians, teachers, students and businessmen directly responsible for quality control". It is a pity that a subject index has not been included, but the book is not too large to be read completely by anyone searching for particular applications. The theory of quality control is developing rapidly, and it is to be hoped that up-to-date editions of the bibliography will be available at not too long intervals. F. J. ANSCOMBE

# THE EXPLORATION OF ANTARCTICA*

By Dr. BRIAN ROBERTS
Scott Polar Research Institute, Cambridge

THE sudden widespread interest in the Antarctic, aroused by the announcement that no less than twelve nations are organising expeditions to that region, has resulted in a spate of articles which has been chiefly remarkable for inaccurate rumours and speculations. Supposed rich deposits of uranium and other valuable minerals have been depicted as the prize for the winners of an international race to stake out territorial claims. It may therefore be useful at this stage to record the present position with regard to sovereignty and territorial claims, to summarize briefly what is known about Antarctic economic resources, and to add some notes about the various expeditions which are now either planned or in operation.

## Sovereignty and Territorial Claims in the Antarctic

There are three areas of British territory in the Antarctic continent, administered by the Governments of the Colony of the Falkland Islands, New Zealand, and Australia, respectively. The Falkland Islands sector consists of the Falkland Islands Dependencies as defined by Letters Patent of July 21, 1908, and March 28, 1917. The New Zealand sector, known as the Ross Dependency, was defined by an Order in Council of July 30, 1923. The Australian sector, known as the Australian Antarctic Territory, was defined by an Order in Council of February 7, 1933.

Adélie Land, a French *enclave*, lies within the Australian Antarctic Territory. It was annexed by France by a decree of April 1, 1924.

Queen Maud Land came under Norwegian sovereignty by a decree of January 14, 1939.

The Pacific sector between the Falkland Islands Dependencies and the Ross Dependency has been partially claimed by the Chilean Government; but no Chilean expedition has ever visited this region. A Chilean decree of November 6, 1940, defined the sector between long. 53° W. and 90° W. as Chilean territory.

Since 1939 the Argentine Government has been pursuing an increasingly active policy to extend its earlier claim to the South Orkney Islands to the whole of the Falkland Islands Dependencies between long. 25° W. and 68° 34′ W. It will thus be noted that the Chilean and Argentine claims not only overlap with each other but also conflict with the British claim to the Falkland Islands Dependencies.

Finally, although United States citizens have laid claim to various regions in the Antarctic since Admiral Byrd's first expedition in 1928–30, the United States Government has never made any territorial claims in the Antarctic. So recently as December 27, 1946, Acting Secretary of State Dean Acheson repeated that his Government has not recognized any claims of any other nations in the Antarctic and has reserved all rights which it may have in those areas.

## Economic Resources

Antarctic lands are barren, with little immediate prospect of any discoveries of minerals of commercial significance. Antarctic seas, however, support an extremely rich fauna, and for forty years the whaling industry has produced great profits. There is also a small but flourishing industry in seal oil. Apart from these, almost nothing is known about the economic resources of the region.

Low-grade coal or carbonaceous shales have been located in the Beacon Sandstone formation at Mt. Buckley, at the head of the Beardmore Glacier; at Granite Harbour in Victoria Land; in the Queen Maud Range; and at Horn Bluff in King George V Land. The reserves are probably large, but the samples examined are charred by volcanic action; and all the sites except Horn Bluff are far inland and inaccessible. Very small quantities of gold and silver have been found at Cape Denison in the Australian Antarctic Territory. Cassiterite (tin ore) has also been found in the Australian Antarctic Territory. Galena (lead ore) and pyrites (iron sulphide) have been found far inland in Marie Byrd Land in the Pacific Sector. Iron pyrites and copper ore have been found in the South Shetland Islands and Palmer Archipelago in the Falkland Islands Dependencies. All these occurrences have been insignificant. In short, nothing has yet been found of sufficient value to make exploitation worth while at such great distances from any market. It is scarcely necessary to add that no radioactive minerals or oil have been discovered in any part of the Antarctic. On the other hand, Antarctica is a continent of approximately six million square miles. Although most of this area is covered by an ice sheet, there are innumerable outcrops of accessible rock, and it would indeed be surprising if a sufficient search did not disclose mineral resources.

## Expeditions

*British.* In 1943 the Colonial Office made arrangements to resume scientific and survey work in the Falkland Islands Dependencies. This programme, which was started during the War, has since been put on to a peace-time footing, and the organisation has been named the Falkland Islands Dependencies Survey. It is planned that this work in the land areas of the Dependencies will supplement the investigations carried out by the "Discovery" Committee and other British expeditions before the War.

In February 1944, parties, led by Lieut.-Commander J. W. S. Marr, R.N.V.R., were established at Port Lockroy in the Palmer Archipelago (Base A: ten men) and at Deception Island in the South Shetlands (Base B: four men). An attempt to establish a third base at Hope Bay in Trinity Peninsula was frustrated by adverse ice conditions. Two ships were employed: H.M.S. *William Scoresby* and *Fitzroy*. It was officially announced in the Press on April 24, 1944, that arrangements had been made to resume scientific and survey work in the Dependencies, and that fully equipped bases had been established. For security reasons, however, no information could be given during the War about the locality of the bases.

In the southern summer of 1944–45 three ships were employed: H.M.S. *William Scoresby*, *Fitzroy* and *Eagle*. A third base was established at Hope Bay (Base D) in February 1945, and four men were again left at each of the first two bases. A further hut was erected at Sandefjord Bay on Coronation Island in the South Orkneys. Commander Marr had to return to England owing to ill-health, and the command of the expedition was given to Captain A. Taylor, R.C.E. Dog teams and sledging equipment

* This article was accepted on January 22; it therefore takes no account of later developments.

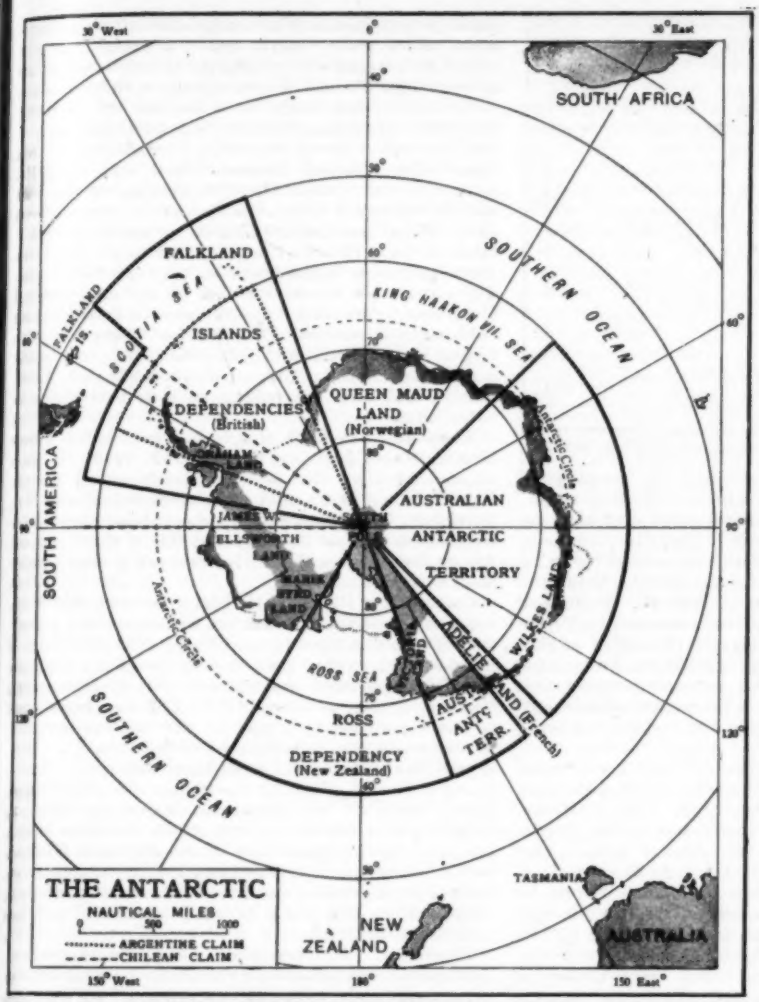


FIG. 1. THE ANTARCTIC SHOWING VARIOUS TERRITORIAL CLAIMS. SHADED AREAS HAVE BEEN ACTUALLY SEEN BY EXPLORERS

enabled the party at Hope Bay to sledge southwards during 1945, surveying James Ross Island and the mainland coast southwards to Cape Longing.

In December 1945 relief parties were sent out under the command of Surgeon-Commander E. W. Bingham, R.N. *Fitzroy* and H.M.S. *William Scoresby* were again employed, and a new ship, *Trepassey*, built in Newfoundland especially for ice work, made possible a more extended programme. Eight men were left at Hope Bay, and four each at Deception Island and Port Lockroy. New bases were established at Cape Geddes on Laurie Island in the South Orkneys (Base C: four men), and at Neny Fjord in south-west Graham Land (Base E: ten men). The old huts of the British Graham Land Expedition of 1934–37 at the Argentine Islands and Debenham Islands were repaired for the use of the Falkland Islands Dependencies Survey. A further supply of dogs and sledging equipment enabled the parties at the two mainland bases to carry out a series of survey journeys.

Meteorological stations are maintained at all these bases, and an investigation is being carried out into the possibilities of weather forecasting in the South Atlantic with particular reference to the development and movement of Antarctic depressions. Extensive geological and biological collections have been made, and the whole project has been planned with the view of making a systematic study of all aspects of the Falkland sector of the Antarctic. In December 1946 relief parties were again sent out from England in *Trepassey*, and it is this routine relief which has been incorrectly reported as a new British expedition.

A feature of the Falkland Islands Dependencies Survey has been that of Commonwealth and Empire co-operation with the United Kingdom. The staffs of the shore stations have included men from Australia, Canada, New Zealand, South Africa, Rhodesia and the Falkland Islands, while the crews of the *Eagle* and *Trepassey* came from Newfoundland. The Falkland Islands Dependencies Survey acts under the authority of the Governor of the Falkland Islands and the general direction of the Colonial Office with the co-operation of the Scott Polar Research Institute and the "Discovery" Committee.

No other activities originating in the United Kingdom are at present in progress in the Antarctic. The "Discovery" Committee's organisation and work in England are continuing, and it is possible that the Committee's ships will be re-commissioned.

*United States.* Two American expeditions will be working in the Antarctic this season, one sent out by the Navy Department under the command of Rear-Admiral R. E. Byrd and the other led by Lieut.-Commander Finn Ronne, backed by the American Geographical Society and other private organisations.

The Navy Department expedition was officially announced on November 12, 1946, and is the largest operation ever planned in the Antarctic. The objectives of the expedition are stated by the Navy Department to be (*a*) "training personnel and testing equipment in frigid zones", (*b*) "consolidating and developing the results of the U.S. Antarctic Service Expedition of 1939–41", (*c*) "developing naval techniques for establishing, supporting and using bases

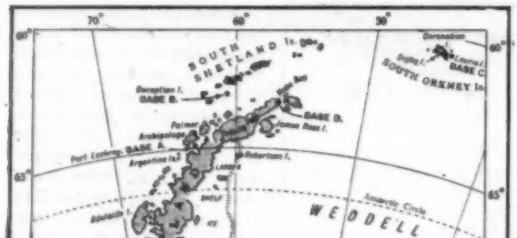


FIG. 2. BASES OF THE FALKLAND ISLANDS DEPENDENCIES SURVEY

under comparable conditions", and (*d*) "amplifying knowledge of the area with respect to hydrographic, geographic, geological, meteorological and electromagnetic propagation methods". For this purpose a task force of the Atlantic Fleet, augmented by units of the Pacific Fleet, has been assigned to the Antarctic during the navigable season of 1946–47. Technical control of the expedition is being exercised by Rear-Admiral Byrd, who is on duty in the Office of the Chief of Naval Operations as adviser on Arctic and Antarctic matters, and who is accompanying the task force. The commander is Rear-Admiral Richard Cruzen, who was Admiral Byrd's second-in-command in the 1939–41 expedition.

The task force has been divided into three main groups. The Central Group includes the flagship and headquarters communication ship, U.S.S. *Mount Olympus*, the Coast Guard icebreaker U.S.S. *Northwind*, Navy icebreaker U.S.S. *Burton Island*, the cargo ships U.S.S. *Yancy* and U.S.S. *Merrick*, and the submarine U.S.S. *Sennet*. The East Group is under the immediate command of Captain George J. D. Dufek. It includes the seaplane tender U.S.S. *Pine Island*, the oiler U.S.S. *Canisteo*, and the destroyer U.S.S. *Brownson*. The West Group is under the immediate command of Captain Charles A. Bond. It includes the seaplane tender U.S.S. *Currituck*, the oiler U.S.S. *Cacapon*, and the destroyer U.S.S. *Henderson*.

It is not intended that any of these ships should remain in the Antarctic during the southern winter, but a shore base capable of supporting a small party for at least eighteen months will be established, possibly on the site of Admiral Byrd's former base at 'Little America' on the Ross Shelf Ice, "to provide against contingencies". Aircraft for shore-based flight operations will be flown in from an aircraft carrier after this base has been set up. Each of the two large seaplane tenders carries three camera-equipped Martin Mariner patrol seaplanes, a small scout plane and two helicopters. Each of the two icebreakers carries one scout seaplane and one helicopter. Long-range operational and mapping flights are to be made by the Mariners, while the scouts will be used mainly for short-range ice reconnaissance and the helicopters for rescue work in case of forced landings.

While the purposes of the operation are described as primarily of a military nature (that is, to train naval personnel and to test ships, aircraft and equipment under polar conditions), the expedition will afford an unequalled opportunity to collect scientific information. To take full advantage of this, arrangements have been made for a number of scientific workers to participate under the general guidance of the Director of Naval Research, Rear-Admiral P. F. Lee. The Weather Bureau, Coast and Geodetic Survey, Coast Guard, the U.S. Geological Service, the Hydrographic Office, the material bureaux of the Navy Department and other Government scientific agencies have provided meteorologists, geographers, oceanographers, hydrographers, photographers, etc. The Army will be represented by air and ground force observers and by quartermasters interested in clothing and rations. The Marine Corps has furnished a part of the air flight crews and other cold-weather specialists. Altogether, approximately 4,000 officers and men are taking part in this gigantic expedition.

Thirteen vessels of the task force sailed from United States ports on December 2, 1946. It was announced that the eastern group would go to Peter I Island and would work eastwards round the continent. The western group would head for a point south-west of New Zealand and follow the coast of Antarctica westwards. The central group would head for the Ross Sea.

Commander Finn Ronne plans to visit the west coast of Graham Land and has announced his intention of establishing a base in Marguerite Bay, where his party of twenty men would spend the winter. The Diesel-powered wooden ship *City of Beaumont*, formerly known as *Navy ATA—215*, has been lent to the expedition by a special Act of Congress and should reach the Antarctic by mid-February. The expedition is equipped with three aircraft. Commander Ronne plans to re-occupy the old "East Base" huts of the American Antarctic Service Expedition of 1939–41, which are on the same small island as the southern base of the Falkland Islands Dependencies Survey. The situation which may arise from two independent and unco-ordinated expeditions based within 200 yards of each other will not be without difficulties.

*Argentina*. In November 1946 the Argentine Government made known its intention to establish "a permanent meteorological observatory" to complement the one it has for long maintained in the South Orkney Islands. On December 20 the Argentine Press announced that the naval transport *Patagonia* would shortly be sailing for the Antarctic. The vessel sailed from Buenos Aires on January 4 and will be assisted by three other ships—the transport *Chaco*, the oil tanker *Ministro Ezcurra*, and a whale-catcher. The expedition, which is equipped with an amphibian aircraft, is carrying a relief party for the existing Argentine meteorological station at Scotia Bay on Laurie Island in the South Orkneys. It is stated that the expedition "intends to explore the Antarctic sector of Argentina", as far as 74° S. (that is, the west coast of Graham Land), returning home at the end of March. It was confirmed that the expedition is also to establish a new Antarctic meteorological station and to "reaffirm Argentina's claim to sovereignty over the entire zone lying between the Argentine mainland and the South Pole". An Argentine wireless news bulletin of January 3 stated that a Chilean naval officer would accompany the expedition, reciprocating the gesture of the Chilean Government in including Argentine officers in its expedition.

*Chile.* On December 14, 1946, the Chilean Foreign Office announced that preparations were being completed to send the frigate *Iquique* and the transport *Angamos* of the Chilean Navy to Antarctica "to establish contact with that most remote corner of the national territory and to determine on the spot all of the possibilities it offers to the country". This statement confirmed that two Argentine naval officers would go with the Chilean expedition to "the American sector of Antarctica" (that is, the sector facing the tip of South America), and concluded that the Government was "taking the greatest interest in the distant Antarctic zone, considering that it forms a prolongation of the soil of the motherland and that it contains important resources for the national economy". Later unconfirmed reports from Chile state that this expedition consists of three ships which will all return to Chile in March 1947.

*Australia.* Sir Douglas Mawson has for long been advocating the establishment of a permanent research station on the Antarctic coast south of Australia. In 1939 the *Wyatt Earp* was purchased by the Commonwealth Government with the view of transporting scientific parties to the Australian Antarctic Territory. The War necessitated postponement of these plans, and it has not yet been possible to recondition the *Wyatt Earp* after her war-time coastal patrol work. On December 20, 1946, it was announced that the Australian Cabinet had decided to send a naval vessel, equipped with a suitable aircraft, on a short reconnaissance voyage to the Antarctic this season to locate a suitable site for a base to be occupied next year. It was also stated that the Commonwealth Government would proceed immediately with plans for the exploration of the Australian Antarctic Territory. A later announcement, however, indicates that this reconnaissance expedition will not take place this season.

*New Zealand.* On December 28, 1946, Mr. Peter Fraser made a statement about the official New Zealand attitude. The New Zealand Government, he said, had no desire to send any expedition to the Antarctic ahead of that led by Admiral Byrd for the purpose of asserting sovereign rights in the Ross Dependency. It had been hoped for some time to extend scientific work in the Antarctic, but the War had made this impossible. A departmental committee was investigating the practicability of establishing a permanent scientific station in the Ross Dependency, and the dispatch of an expedition next year would be considered when the examination was completed. New Zealand hoped to co-operate with the United Kingdom and Australia in an international plan of Antarctic research: details of which were still under discussion. The Americans were welcome to fly over New Zealand territory.

*South Africa.* In 1944 a South African Antarctic Research Committee was formed on the initiative of the Geological Society of South Africa at Johannesburg. This Committee has for more than two years been actively considering the possibility of a South African Antarctic expedition and has been in close touch with those in the United Kingdom who are interested in similar projects. The suggestion has been put forward that a South African expedition should establish a base in Coats Land. General Smuts has advised the Committee that the South African Government would not be likely to support the project unless other nations showed interest in a joint scheme. The Committee continues its investigations, and, as a start, has accepted an offer to send a South African geologist to join the staff of the Falkland Islands Dependencies Survey.

*International Expedition.* Plans for a British–Norwegian–Swedish expedition to the western part of Queen Maud Land are being discussed. The area to be investigated was photographed from the air by the Germans in 1938–39 and was named by them Neu-Schwabenland. The German maps and photographs reveal a remarkable area of ice-free land which offers a field for research of the first scientific importance. British participation in this expedition is being discussed by a joint Committee of the Royal Geographical Society and the Scott Polar Research Institute. It is proposed that this expedition shall be purely scientific, and it is unlikely to start before 1948 or 1949.

*Whaling expeditions.* The Antarctic whaling season opened on December 8, 1946, and extends to April 7 next. In view of the present world food shortage, the results will be awaited with more than usual interest. Whale oil is used in the margarine and lard compound industry and for making soap; important by-products are fertilizers and animal feeding stuffs.

The 1945–46 whaling season was disappointing, due mainly to bad weather and the unpreparedness of the principal fleets. The total oil production was only 820,883 barrels, compared with 2,820,771 barrels in 1938–39. This season fifteen floating factories with their fleets of catchers have sailed for the Antarctic, comprising seven from Norway, three from the United Kingdom, one from South Africa, one from the Netherlands, one from the U.S.S.R., and two from Japan—the last despite protests from other participants owing to that country's failure in the past to observe the restrictions imposed by the International Whaling Convention. This is the first occasion upon which the Netherlands and the U.S.S.R. have undertaken whaling in the Antarctic. Apart from the three land stations at South Georgia, all these whaling expeditions will be operating at sea, mainly outside territorial waters.

The post-war regulation of whaling was considered at an international whaling conference held in Washington last November. The short-term need for oil and the long-term need to preserve the stock of whales are difficult to reconcile; but it is generally agreed that the stock must be protected by a total limit to the Antarctic catch. Although the total catch must be shared by a number of nations, it is not expected that this will be a source of international dispute at the present time.

The news of all these expeditions has failed to evoke the expressions of pleasure and interest from foreign countries which formerly accompanied such enterprises. The Russian Press has charged the United States with prospecting for uranium in order to increase their stock of atomic bombs. The Argentine and Chilean Press have complained that the British and American expeditions are equivalent to a trespass on their national territories. American, British and Dominion newspapers speculate on the race for uranium and other minerals, and emphasize the political rivalry which is accompanying the partition of the last continent.

It is a sad reflexion on current political psychology that such claims and charges should invade a field which was once characterized by international courtesy and goodwill. What is now happening is the realization on the part of all concerned that the economic development of this frozen continent is

technically within sight—providing there is anything there which is worth the trouble of development. The political question which is now beginning to arise—well in advance of any economic necessity—is by whom, and in what way, development is to be undertaken. There is room enough and to spare in Antarctica to absorb all the energy and enterprise which can be devoted to it. The greater part of the continent is still unexplored, and there are countless unsolved problems awaiting investigation. This task of exploration is essentially one that demands international co-operation. While official interest is now undoubtedly solving the greatest difficulty of earlier explorers, namely finance, the hurried preparations for most of the present expeditions can only result in much wasted effort. Moreover, friction is almost unavoidable when two or more expeditions plan, without prior consultation, to operate in the same area.

The Colonial Office has made it clear that it will always welcome foreign co-operation in the exploration of the British territories in the Antarctic which are administered by the Falkland Islands Government. It is impossible, however, to arrange co-operation between expeditions which keep their plans secret until they sail. In Great Britain provision exists for international co-ordination in the Scott Polar Research Institute and the Royal Geographical Society, which have recently set up a joint Antarctic Research Committee. Mention has already been made of the similar Committee which has for some time been in existence in South Africa. When the British Empire Scientific Conference met at Cambridge in June 1946, useful preliminary discussions about Antarctic exploration and research took place at the Polar Institute. The foundations have been laid for maintaining closer contacts and for training Dominion research workers in polar techniques in the Falkland Islands Dependencies. It is to be hoped that this co-operation will be developed to the fullest possible extent.

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# THE MISSION OF THE UNIVERSITIES

By J. MACKAY-MURE

RECENT events have resulted in strong pressure on the universities to increase the number of students. The Barlow Committee, in recommending that the present output of university scientific workers should be doubled "at the earliest possible moment", expressed the hope that there might be a similar increase in the number of arts students. The Clapham Committee urged a large increase in the provision made by the universities for teaching and research in the social sciences. It is, however, extremely doubtful whether the existing universities are in a position to double their output of students within the next ten years without surrendering their essential character and independence. As the universities expand they will have to recognize that the great bulk of their funds, both for purposes of income and of capital expenditure, can only come from the Government, and there is a growing nervousness lest the Government, which is now paying the piper to the tune of £9,000,000 a year, will soon want to call the tune.

While it is undoubtedly true that the universities are facing an organisational crisis, brought about by the pressure of new demands for trained personnel, this is less than the whole truth. They are also facing a crisis about themselves and their function in society. Because the genuine freedom of a university is created from within and can only be destroyed from within, academic freedom is, or ought to be, more than a tradition of the universities. The necessity for it has, unhappily, tended to be obscured in recent years by the importance which has been attached to the teaching function of a university. If too much emphasis has been placed on this and other activities which it is right and proper that a university should, in certain circumstances, pursue, too little attention has been paid to those which it has a bounden duty to pursue at all times and under all conditions. The modern doctrine that the primary function of a university is to supply experts in the spheres of science, business, administration, and the social sciences can become both dangerous and heretical—not because it advocates any single thing which ought not to be done, but because it represents an idea of a university which is out of focus. It thrusts into the background that conception of it as a centre of cultural life and cultural progress which makes freedom not merely desirable but a first essential. Without freedom such a centre ceases to be a university, a community of scholars within which every man may open his mind to a total engagement in the struggle for truth.

The maintenance of this freedom has to-day acquired a new significance. As the State system of education is reformed and developed, there is the assurance of that technical and vocational training on which the efficiency of the community depends. But the quality of the community depends primarily on its standards and its ideals, on the defence and promotion of fundamental values in life and progress. Although standards and values are by no means the monopoly of those who are brought into association with the life of a university, it is doubtful whether they can be maintained if the true idea of a university is allowed to decay. "It is not," says Plato, "the life of knowledge, not even if it includes all the sciences, that creates happiness and well-being, but a single branch of knowledge—the science of good and evil." Science, economics, and sociology provide the frame of contemporary society and satisfy its material needs, but "unless we have the knowledge of good and evil, their use and excellence will be found to have failed us".

Since nothing would be more disastrous than that the immensity of this issue should be made an excuse for pursuing a policy of *laisser-faire*, the decision of the General Council of the Student Christian Movement to call together a commission of senior members of the universities to help it "to consider the fundamental pre-suppositions of university education and their implications for the work of the S.C.M. in the post-war university" must be widely welcomed. As a result of the discussions of the commission, which met in 1944 and 1945, certain points of broad agreement emerged "in respect of (*a*) a criticism of the philosophy underlying modern university education; (*b*) the Christian reasons for supporting and defending with vigour a 'free' or 'liberal' university; (*c*) the essential beliefs necessary to maintain such a university; (*d*) the responsibilities of a Christian student in such a university". In order to get the matters with which the commission was concerned

more widely discussed, the S.C.M. has now issued a series of twelve University Pamphlets[1] on different aspects of the problem.

By no one has the problem been more clearly stated than by Ortega y Gasset when he declared that the universities are "living below the demands of their time". "There is," to quote from his lively and stimulating "Mission of the University"[2], "no denying the fact that man invariably lives according to some definite ideas which constitute the very foundation of his way of life. . . . We are passing at present, despite certain appearances and presumptions, through an age of terrific *un-culture*. Never perhaps has the ordinary man been so far below his times and what they demand of him. Never has the civilized world so abounded in falsified, cheated lives. . . . Hence the historic importance of restoring to the university its cardinal function of 'enlightenment', the task of imparting the full culture of the time and revealing to mankind, with clarity and truthfulness, that gigantic world of to-day in which the life of the individual must be articulated, if it is to be authentic."

Accepting this diagnosis in "The Mind of the Modern University", Prof. John Baillie concludes that the present crisis can be traced to the failure of the universities to remain "closely integrated communities, inspired by a common purpose and cemented by certain common and firmly held convictions". This has led at the universities to a "refusal of definite commitments" and "the cultivation of a continued suspense of judgment". Although no man and no institution can live without a working basis of belief, Prof. Baillie naturally rejects the idea of coercing students to adopt any single philosophy of life. At the same time, he insists that it is a primary duty of a university to confront its members with the importance of possessing a clearly defined philosophy of life. Failure to do this is, he maintains, "an abnegation of the very purpose for which a university exists".

The magnitude and difficulties of this task are frankly faced by Prof. H. A. Hodges[3]. What is not, he says, sufficiently understood is that knowledge is a source of power. The universities are trafficking in a commodity the acquisition of which means power, and are caught in the same contradiction between professed aims and real desires as affects the whole of society. "The world has," he continues, "never been fuller of high hopes and high principles than in the last hundred years. The hopes have not been realized and the principles have been ineffective. Why? Because there is a contradiction between the principles we profess and the desires by which we are actually moved. Our ideals, in which our conscious selves sincerely believe, are full of justice, humanity and peace. . . . But our imaginations, as reflected in art and literature, in popular amusements, and in our actual behaviour, are full of something else. Our admiration and emotional attachment go to power, and to knowledge as a source of power." Believing that this conflict between professed principles and effective archetypes is common to all contemporary social and political movements, Prof. Hodges finds no difference in this respect between liberal democracy of the Atlantic type and authoritarian communism on the Russian model.

Since this belief is held, in greater or lesser degree, by all the authors in this series, it is not surprising to find them also agreed in insisting that members of a university have, in Miss D. M. Emmet's phrase[4], a responsibility to focus "the intellectual conscience of the community". Nevertheless, she is emphatic that the first responsibility of a university, not only for its own sake but also for the sake of the community, is to *be* a university. "It should," she continues, "be a place where the criticism and evaluation of ideas is continually being carried forward; where 'nonsense' can be exposed for what it is; and where the 'intellectual virtues' of sincerity of mind are being fostered and transmitted."

Few, if any, will dispute Miss Emmet's conclusion that, within a totalitarian or purely utilitarian society, the university can only lose its soul or fight for it; but neither she nor any of the other authors in the series is able to offer a positive solution of the immediate problem. The American expedient, recommended in the report of the Harvard Committee, is to provide students with 'integrating courses' designed to give a conspectus of knowledge or an introduction to some of the major issues of our time. But who are to be the integrators? And are such courses, however good, more than an admission of the magnitude of the problem? The sum total of human knowledge far exceeds the power of the human mind to contain it. The old unity of knowledge, or the belief that such a thing as truth about the whole system of things exists and can be found by human minds, is gone. But, however curricula may be devised and courses integrated, it is still possible for universities to be places in which real battles rage; and, as long as the battles are concerned with fundamental issues and the combatants are fired with a determination to find a clearly defined philosophy, the universities will retain their cardinal function of 'enlightenment'.

[1] Student Christian Movement Press, Ltd., 58 Bloomsbury Street, London, W.C.1. 1*s*. each. Full list of titles is contained in each pamphlet.
[2] Kegan Paul. 7*s*. 6*d*.
[3] "Objectivity and Impartiality." Pamphlet No. 2.
[4] "The Foundations of a Free University." Pamphlet No. 4.

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# ASTROLOGY AND ASTRONOMY IN THE SEVENTEENTH CENTURY

By JOSHUA C. GREGORY

ASTROLOGY was an integral part of astronomy and science from Ptolemy onwards. Many astrologers lived before A.D. 170, when Ptolemy flourished at Alexandria; but he conveniently dates the beginning of an astrological fervour by giving the science a philosophy. Kepler dates the finish of the astrological vogue much less sharply, for the horoscopes only melted slowly out of seventeenth-century science. There were, of course, dissents during the long astrological grip on the best minds: they were active in the beginning and they were gathering towards the end. Astrology, however, as the history of science from Ptolemy to Kepler shows, is one firmly established and finally discarded hypothesis of science.

This is clear in Lynn Thorndike's six volumes, "A History of Magic and Experimental Science" (1923–41). Thorndike includes astrology under magic. Whether this is right or wrong, his exhaustive and valuable survey includes the astrological data. He begins with the first century A.D. and ends with the sixteenth. His history of this period, his occasional extensions into the seventeenth century, and many supplemental data, disclose astrology as an integral part of astronomy from Ptolemy to Kepler.

A modern astronomer who took fees for casting horoscopes would be legitimately suspected of deceiving victims who pay because they are deceived. A paragraph on the "Fourth Centenary of the Birth of Tycho Brahe", in *Nature*, Nov. 23, p. 740, suggests that earlier astronomers of those days earned a living by palming off horoscopes on the credulous; this ignores the persisting grip of astrological beliefs when Tycho Brahe and Kepler lived.

The Copernican system had an astrological part at first, though the movements of the earth, rather than the stellar motions, influenced destiny. When the "De Revolutionibus" was published on behalf of Copernicus in 1543, it was stripped of this astrology. Osiander's editing tried to soften any papal opposition to the new astronomy (Thorndike, l.c., 1941, **5**, 413f.). If the astrology was stripped off to assist the softening, an astrological astronomy deferred, in this instance, to possible papal protests against horoscopes.

Tycho Brahe does not surprise the historical sense by vindicating astrology, or by compiling annual predictions for the Court at Copenhagen, or by casting horoscopes for the royal family. Astrology was still rife when he died in 1601. Sir Francis Bacon accuses astrology of many errors; but he also exhorts science to reconstruct it justly.

Astrology is losing its grip in "The Anatomy of Melancholy" (1621), but has not yet lost it. Robert Burton seems to admit in one place that the stars are the most remote causes of "Heroical Love". In another he does not try to decide between astrological physicians and their opponents. He exclaims against the vanity of "genethliacal studies", but he notes that Saturn was lord of his geniture, that he had Jupiter in his sixth house, and that Mars had a hand in the matter. The stars do incline: Burton retains this astrological faith. They incline too gently, however, to compel those whom reason rules: he softens down the astrological power to decree or enforce. Christian astrology had frequently refused to place man's freedom at the mercy of the stars or planets. A prolonged powerful grip is perceptible in Burton's many references to astrological lore; his attempt to believe in astrology without believing too much suggests a loosening of the grip.

Sir Thomas Browne, in "Religio Medici" (1643), seems, somewhat ambivalently, to believe and disbelieve. No laborious argument against astrology is needed, for any truth it may have does not injure divinity. If astrology has any truth, Sir Thomas notes, he may "outlive a Jubilee". He does not "revolve Ephemerides and Almanacks in expectation of malignant aspects, fatal Conjunctions and Eclipses", but he does suspect a piece of the "Leaden Planet" in himself since he was born "in the Planetary hour of Saturn". In the "Pseudodoxia Epidemica" (1646), he does not condemn astrology as a popular error when he warns men against the pretentious astrologer who abuses the "worthy enquiry" of the stars. Satan also deceives men, Browne thinks, by "conceits of stars and meteors" other than "their allowable actions". In "Christian Morals", published in 1716 after his death, Sir Thomas commends the "celestial aspects" for admonition and advertisement, though they should not determine men's ways.

Bacon restricts "celestial operations" to "masses of things" and excludes the "calculation of nativities" from rational astrology. Burton and Browne obviously knew their own nativity horoscopes, and many others thought it at least prudent to know theirs. The degree of belief in the accuracy of the casting or in the horoscope when cast probably varied; but, as Browne hints, the horoscope might contain wholesome warnings. Any astrologer could conscientiously cast horoscopes under such conditions. The horoscope, precautionary or more trusted, did not necessarily involve an insistence on fatal necessity in the stars. The more prudent astrologers, Bacon admits, had always denied such fatal necessity.

The astrology which had prevailed widely among the intellectual élite since Ptolemy persisted pertinaciously. A Kepler who checks his own horoscope on the events of his own life, and, as Singer says, keeps in effect an "astrological diary", is historically quite intelligible. He is equally intelligibly an honest caster of horoscopes for the many who still believed in them—wholeheartedly or with varying qualifications.

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# OBITUARIES

## Dr. F. F. Blackman, F.R.S.

FREDERICK FROST BLACKMAN was born on July 25, 1866, and died on January 30, 1947. His was a full life, which resulted in valuable contributions to botany, and to his University and College, of which he was a member for nearly sixty years.

His first published contributions to botany were two papers in the *Philosophical Transactions of the Royal Society* in 1895. They began a series entitled "Experimental Researches on Vegetable Assimilation and Respiration", of which the twenty-first paper appeared in 1933. Only a few of the series bear Blackman's name, but all reveal the impress of his mind. They are a record of some of the investigations carried out by him and by the students working under his leadership. In all these researches he played an important part not only during the experimental work but also in marshalling the results for publication. In 1928 a new series commenced with three papers entitled "Analytic Studies in Plant Respiration". Other papers for this series have for some time been in a state which those with a less exacting standard than Blackman's would consider ripe for publication. These two series record the main field of his scientific activities. The views and discoveries he has already recorded have been so incorporated into the body of biological knowledge that their epoch-making character may be forgotten. It is a commonplace to elementary students that most of the gaseous exchange between leaves and the atmosphere takes place through stomata; but although this was suggested so long ago as 1832, it was much disputed until convincing experimental evidence was provided by Blackman in 1895. Whatever may be decided concerning the degree of generality of his Theory of Limiting Factors there is no doubt that the paper on "Optima and Limiting Factors", which he published in 1905, provided an outstanding clarification of biological thought and has had far-reaching effects. He was the last person to think that he had achieved finality in his formulations; as he liked to express it, he was making a first approximation to the truth, and he hoped it would pave the way for a closer approach. He was a pioneer in the application of precise quantitative methods in plant physiology and in the application of physico-chemical laws to the interpretation of biological processes. Yet he never failed to realize

the complexities of the organisation of biological systems, and he retained his interest in these problems to the end.

Blackman's other major contribution to botany was the effect he had on those who had the privilege of listening to his lectures and on those who had the even greater privilege of doing research under his guidance. His lectures were masterly presentations of experimental results marshalled in such a way as to illuminate his theme. Much of the material was drawn from investigations made under his guidance, while that garnered from biological literature often appeared in a completely new form after having been subjected to his analytical mind. To experience to the full the discipline of his ways it was necessary to work on a problem under his guidance; his was a precise mind which gently indicated the right path. To see one's presentation of the results of an investigation analysed and then synthesized into a new form was indeed an education. He performed this service for many others who sought his advice.

Blackman was a member of the staff of the Cambridge Botany School from his appointment as demonstrator in 1891 until his retirement from the readership in botany in 1936, and as such he undertook a full share of the administrative work of the department. This, together with his wise advice, which continued after his retirement, contributed largely to its smooth running. He was a perfect colleague, and he had the gift of inspiring all, both staff and assistants, to give of their best. When the time came for the extension of the Botany School in 1933, he devoted as much thought to the planning of the new facilities as he had done to the running of the old department. He not only formulated his own requirements down to the smallest detail but also stimulated others to proceed in the same way.

When, in recognition of the active school which had developed under Blackman's inspiration, a Sub-Department of Plant Physiology was created in 1931 with the aid of a benefaction from the Rockefeller Fund, he naturally took charge, and but for complications of age and date of retirement he would have become the first professor of plant physiology in Cambridge. On relinquishing the readership his old students and associates presented him with his portrait, painted by Henry Lamb, which now hangs in the Botany School.

Elected a fellow of the Royal Society in 1906, he was awarded a Royal Medal in 1921, and gave the Croonian Lecture in 1923. He was president of the Botany Section of the British Association in 1908 and president of the Section of Plant Physiology at the International Botanical Congress held in Cambridge in 1930.

He devoted much time and thought to the affairs of St. John's College, of which he was steward for several years and in which he lived as a bachelor fellow until 1917. His advice on a wide range of subjects, including the preservation of old buildings, the erection of new ones, pictures, plate and many others, was sought and respected.

In 1917 he married Elsie Chick. They planned and built a house and surrounded it with a garden which gave them and their friends great pleasure, and provided opportunities for the exercise of his artistic and botanical interests. Mrs. Blackman and their son survive him.

Blackman had the same approach to all problems. He collected the facts and considered them carefully and dispassionately before giving his opinion. It was done so thoroughly and unobtrusively that there was a temptation not to notice the care that he had bestowed. He was as gentle as he was wise. To those who knew him well Blackman was a great man.

G. E. Briggs
F. T. Brooks

## J. W. Sandström

Johan Wilhelm Sandström, meteorologist and oceanographer, who died in January 1947, was born on June 6, 1874. He was chief of the Meteorological Division of the Meteorological and Hydrological Institute of Sweden during 1919–39.

After leaving school, Sandström began life in a factory, but he came under the notice of I. Bendixson, professor of mathematics in the University of Stockholm. Bendixson managed to arrange that Sandström should have time off to go to lectures at the University. He took a keen interest in the promising young man, and the development of Sandström's mathematical talent was largely due to Bendixson's influence.

In 1898 Sandström became a pupil of V. Bjerknes, and his first substantial contribution to meteorology was a paper in the *Meteorologische Zeitschrift* (April 1902) on the "Relation between Temperature and Wind in the Atmosphere under Stationary Conditions", in which he applied to this problem a development by Bjerknes of Kelvin's classical paper of 1869 on vortex motion. Sandström arrived at the conclusion that in Europe, cyclones usually have a cold centre and anticyclones a warm centre, and he indicated the significance of the 'thermal wind', though he did not give it that name, which came nearly sixteen years later. He noted also, what has recently been rediscovered, that North American cyclones are in a much earlier stage of development than European cyclones.

Sandström next collaborated with Helland-Hansen in computing exhaustive tables for the application of Bjerknes' circulation theory to the currents of the ocean. He was also joint author with V. Bjerknes of the first volume of "Dynamic Meteorology and Hydrology", published by the Carnegie Institution of Washington in 1910—the first instalment of a treatise designed to present in an ordered and rational form the principles and development of meteorology and hydrography from the point of view of a mathematical physicist. The treatise was completed by the publication in 1932 of the magnificent three volumes on "Physical Hydrodynamics with applications to Dynamical Meteorology", in which V. Bjerknes had the assistance of J. Bjerknes, T. Bergeron and H. Solberg. But Sandström's help and encouragement had been outstanding and were fully recognized by V. Bjerknes, who acknowledged in the preface that without it he would scarcely have ventured on this great work.

Later in life, Sandström was occupied almost entirely with investigation into the Gulf Stream and its influence on climate. He was not content to use only theory and the observations of others: he made expeditions to test for himself the application of his theory. He prepared a very complete memoir embodying the results of his work. A part of this memoir is being printed by the Swedish Academy of Science and was in the press at the time of his death.

Sandström was a big, genial man. One of his colleagues describes him as a man "with a very vivid and vital interest in Nature and in the problems

suggested by natural phenomena. His theoretical ability, which was combined with a good amount of common sense, was so much more remarkable as he was largely a self-educated man, having risen from the position of an aid in a mechanical factory to being the assistant and collaborator of scientists like Svante Arrhenius, Otto Pettersson and Vilhelm Bjerknes."

Meteorologists in England who knew Sandström either personally or through his writings will join with their colleagues in Sweden in mourning the loss of a great pioneer. E. GOLD

WE regret to announce the following deaths:

Prof. Louis Cobbet, formerly professor of pathology in the University of Sheffield, on March 10, aged eighty-five.

Major M. W. K. Connolly, an authority on the land mollusca of Africa, on February 26.

Prof. Llewelyn G. Owen, formerly professor of mathematics in the University of Rangoon, on February 23.

Mr. H. A. S. Wortley, principal of University College, Nottingham, on February 21, aged sixty-one.

# NEWS and VIEWS

## A Giant Sunspot

A GIANT sunspot group, one of the largest on record, crossed the sun's disk between March 3 and 17, with central meridian passage on March 10·2. Excepting one or two days, the prevailing cloudy skies gave little opportunity for detailed observations, but the following facts may be given. The maximum area of the group, consisting mainly of a pair of great spots, was 4,300 millionths of the sun's visible hemisphere. This exceptionally large area is less than that of the February 1946 spot (4,900 millionths) but greater than that of the July 1946 spot (3,950 millionths). The average area during disk passage of the present spot may, however, be less than that of the July spot (3,750) and is certainly less than that of the February spot (4,400 millionths). Two geomagnetic disturbances, not of great intensity, occurred while the present spot crossed the disk, namely, March 8–9 and March 15–16. Their provisional ranges at Abinger kindly communicated by the Astronomer Royal were

| | *D* | *H* | *V* |
|---|---|---|---|
| 1st storm | 60′ | 270γ | 220γ |
| 2nd storm | 30 | 150 | 120 |

The latitude of the spot group was 22° south, but the tilt of the sun's equator at this epoch of the year brought the group to within 15° of the centre of the disk at central meridian passage. Yet no great magnetic storm occurred about one day after central meridian passage, for which statistical results suggested a high probability. It is significant, however, that radio fade-out data, at any rate in Greenwich daylight hours, indicated that no intense solar flare (like those of February 6 and July 25, 1946) occurred when the spot was within the central half of the sun's surface turned towards the earth. Practically on the same solar meridian as the recent spot was another naked-eye group in latitude 13° north, and with maximum area about 1,400 millionths.

## Effect of the Moon on Radio Wave Propagation

FROM time to time, some observational evidence has been forthcoming suggesting that the strength of signals received from radio transmitting stations over fixed paths is under certain conditions dependent upon the position of the moon at the time of observation. In particular, H. T. Stetson has investigated this matter, and in 1944 (*Terr. Mag. and Atmos. Elec.*, **49**, 9) described the results of the analysis of some eight years measurements taken at Boston on the strength of signals received from the Chicago broadcasting station. Contrary to his expectations, the evidence strongly indicated that the strength of the signals was dependent upon the age of the moon, although the effect was of a complex nature. It will also be recalled that in a paper published in 1939 (*Proc. Roy. Soc.*, A, **171**, 171), E. V. Appleton and K. Weekes showed the existence of a lunar tide effect in the height of Region *E* of the ionosphere. The tide was found to be semi-diurnal, with an amplitude variation of about ± 1 km. If these results are interpreted according to the simple theory of the formation of the ionized regions, they indicate a relative air-pressure oscillation several thousand times the measured relative pressure oscillation at ground level.

In a recent communication to the Editors, Mr. P. A. de G. Howell, 77 Glandovey Road, Fendalton, Christchurch, N.W., New Zealand, claims to have observed during 1938–39 and 1944–45, a correlation between the variation in long-distance transmission conditions at short wave-lengths and the phases of the moon. It was observed that there was a minimum of background noise and high signal strength with little tendency to fade for about two or three days on either side of full phase, these conditions changing to a maximum of noise with poor signals and fading around the time of new moon. The cycle of occurrences is easily confused with those associated with the solar period of similar duration, with which, however, it moves in and out of phase as the months progress. While both Dr. Stetson and Mr. Howell suggest that the effects are the result of changes in ionization in the earth's upper atmosphere, it is clear that the whole subject requires further investigation before definite conclusions can be reached as to the cause of the effect.

## Population Trends and the World's Resources

DR. C. L. BERTRAM has presented in a minimum compass the main known facts of the relationship of population and human needs to the availability of animal and vegetable raw materials and foodstuffs (*Geogr. J.*, **107**, Nos. 5 and 6, May–June 1946). He accepts Carr-Saunders' estimates that the world's population has increased fourfold in the last three hundred years—from 545 million in 1650 to 2,057 million in 1933. Only Africa (100 million to 145 million) has failed to take part in this remarkable increase. Although probably three quarters of the world's people are farmers or their dependants, the majority of these do not get sufficient food to maintain health. Seventy-five per cent of Asia's 1,150 million people have a diet far below the standard for health: even the best-nourished countries, such as

Britain and the United States, had 20–30 per cent of the people suffering from malnutritional diseases before the War. The near-famine conditions now faced by the world are nothing new, but shortages are affecting those who, by their advantageous economic position, had previously been virtually immune from even the fear of famine.

Britain imports the largest quantity of food of any country in the world—in some cases as much in normal times as two thirds of the total of a given commodity entering into the world trade. If exporters are no longer compelled by economic needs to sell the food they badly need themselves, then the position is indeed difficult for the importers. The world position has been aggravated by that greatest scourge ever known to man—soil erosion—and the irrational over-exploitation of forests, fisheries and grasslands. The plea is made for policies based on real knowledge and quantitative data rather than half-knowledge or guess-work.

## 'Wellcome' Photographic Year Book

THE well-known 'Wellcome' Exposure Calculator, Handbook and Diary, published by Burroughs Wellcome and Co., has appeared in a modified form as the 'Wellcome' Photographic Year Book. The contents are similar, and those who made use of the original publication before the War will remember that it consists essentially of a diary, a number of pages ruled for recording the essentials of photographic exposures, a fund of useful photographic information, and a very useful exposure calculator. Used in conjunction with the illustrated examples of different types of subject, the calculator is one of the best of its kind. On the back of the exposure calculator, also in disk form, is a depth of field calculator with which the depth of field can be obtained for lenses of various apertures and focal lengths. The keen photographer will find the Year Book a valuable asset for the pocket.

## Frank B. Jewett Fellowships: Awards

THE American Telephone and Telegraph Company, which founded the Frank B. Jewett fellowships for research in the physical sciences three years ago to commemorate the retirement of its eminent vice-president in charge of development and research, has announced seven awards for 1947–48. The purpose of the fellowships is to stimulate and assist research in the fundamental physical sciences, and particularly to provide the holders with opportunities for individual growth and development as creative scientific workers. The awards carry an annual stipend of 3,000 dollars to the holder and 1,500 dollars to the institution at which the recipient elects to do research. The awards are designedly post-doctorate, and only those who have recently received their doctorates or who are about to receive them are normally considered.

The awards for 1947–48 have been made to: (1) Dr. Martin G. Ettlinger (University of Texas and Harvard University), at present investigating the chemistry of cyclopropene and dicyclobutane derivatives at the California Institute of Technology as a Jewett Fellow for 1946–47; he intends to continue his present research studies. (2) Wallace D. Hayes (California Institute of Technology), who proposes to investigate problems of transonic and supersonic fluid flow. (3) Paul Olum (Harvard and Princeton Universities); he is to carry out research in algebraic topology. (4) Aadne Ore (University of Oslo), at present an F. E. Loomis Fellow at Yale University; he will work on the theory of combinations of electrons and positrons. (5) Dr. Alfred Schild (University of Toronto and the Carnegie Institute of Technology); he will study relativistic field theories in quantum mechanics. (6) Dr. Robert L. Scott (Harvard and Princeton Universities), at present Jewett Fellow, engaged in research in chemistry at the University of California; he is to continue his studies of the thermodynamics of solutions. (7) Edwin H. Spanier (Universities of Minnesota and Michigan), at present a Rackham Predoctoral Fellow at the University of Michigan; he will engage in research in the homotopy classification of continuous mappings.

## British Iron and Steel Research Association: Appointments

MR. R. H. MYERS has been appointed head of the Steel Making Division of the British Iron and Steel Research Association and Dr. A. H. Leckie has been appointed deputy head. Mr. Myers studied under Profs. J. O. Arnold and A. MacWilliam at Sheffield, and, after a post-graduate course of one year, started his industrial career with the Midland Iron Company. Since 1930 he has been associated with research in the steel industry, as open-hearth officer to the Iron and Steel Industrial Research Council, in addition playing an active part in the Corrosion and Heterogeneity Committees set up jointly by the Research Council and the Iron and Steel Institute.

Dr. A. H. Leckie studied chemistry at University College, London, under Profs. F. G. Donnan and C. K. Ingold. After graduating, he was engaged in research for several years on molecular spectroscopy. In 1937 he joined the Technical Department of the British Iron and Steel Federation and was engaged on research on iron and steel works plant and principally on open-hearth furnaces. Dr. Leckie joined the British Iron and Steel Research Association, when that body took over the work of the Federation's Technical Department, and is in general charge of research work on furnace design and operation.

## Radiocommunication Convention

THE Institution of Electrical Engineers is holding a Radiocommunication Convention during March 25–28, at which some seventy papers will be presented dealing particularly with war-time activities in this field and their resulting application to future peace-time development. The Convention will be opened on March 25 by Sir Stafford Cripps, President of the Board of Trade, after which Sir Stanley Angwin will give a lecture on "Telecommunications in War". On March 26 four meetings will be held dealing in turn with long-distance point-to-point communication, naval, military and aeronautical communication, and the special features of pulse modulation in communication systems. The subject of short distance communication will be dealt with during the following morning, while the afternoon and evening sessions of March 27 will be devoted to direction-finding and war-time broadcasting respectively. On the morning of March 28, Sir Edward Appleton will open the session on propagation with a paper entitled "The Investigation and Forecasting of Ionospheric Conditions". The afternoon of the same day will be devoted to radio components, and in the evening, Sir Clifford Paterson will conclude with a review of the Convention and the future trends of development indicated by the papers and discussions. At an

additional meeting to be held on April 2, a number of papers will be presented dealing with the various types of continuous wave radio navigational aids which have been developed during recent years.

## Summer School in X-Ray Crystallography

In recent years the study of materials by means of X-ray diffraction has come to occupy an important place in scientific research both in the universities and in industry. This field of study enters into physical, chemical, metallurgical, mineralogical and biological research. The necessary X-ray technique is, however, highly specialized, and for its proper understanding a fundamental training is required. An attempt to meet the demand for such courses was made at the University of Cambridge by the provision of Summer Schools in the years 1943–46. Although these schools were very successful, they are now to be discontinued; but, if the demand warrants, consideration will be given to their continuation at the Manchester College of Technology under the direction of Dr. H. Lipson. Correspondence should be addressed to the Director of Extra-Mural Studies, University, Manchester, 13.

## Cambridge Summer School in Physical Chemistry

A Summer School on "Some Recent Advances in Physical Chemistry" will be held in the University Department of Physical Chemistry, Cambridge, during August 16–23 inclusive. A course of eighteen lectures will be given by the staff of the Department on the following topics: (1) molecular structure and valency theory (6 lectures); (2) chain reactions (6 lectures); (3) physics and chemistry of rubbing solids (6 lectures). Practical work on these topics will be arranged for those who desire it. Demonstrations will also be given and full opportunity provided for discussion with the lecturers and with those carrying out research in the laboratory. An inaugural lecture will be given on the evening of Saturday, August 16, and the course will finish on the evening of August 23. Arrangements have been made for most of those attending the School to be accommodated in colleges. Applications to attend the School must be received by May 1. Inquiries should be addressed to the Joint Secretaries, Summer School in Physical Chemistry, University Department of Physical Chemistry, Free School Lane, Cambridge.

## Pasteur Exhibition

A Pasteur Exhibition will be held at the Science Museum, South Kensington, London, during April 10–May 26. The exhibition has been arranged and provided, with the assistance of the Cultural Relations Department of the French Foreign Office, by the Palais de la Découverte in Paris, where it has recently been on show. This institution is devoted to the exposition of modern science, employing for the purpose the most advanced techniques of visual education. The Pasteur Exhibition includes a chronological account of the chemical and biological work of Louis Pasteur on fermentation, putrefaction, the spontaneous generation of life, and on the causative organisms of numerous diseases of men, animals and plants. The results of his work are illustrated by panels dealing with pasteurization in the brewing and other industries, and the raising of disease-free silkworms. A section of the exhibition deals with the Pasteur Institutes established throughout the world for the preparation of serums and vaccines for the combating of disease epidemics.

## Fourth International Cancer Research Congress

The Fourth International Cancer Research Congress will be held in St. Louis, Missouri, U.S.A., during September 2–7, 1947. The Union Internationale contre le Cancer having accepted the invitation of the American Association for Cancer Research, the Congress will be held under the joint auspices of these two organisations, with Dr. E. V. Cowdry, professor of anatomy, Washington University School of Medicine, and director of research of the Barnard Free Skin and Cancer Hospital, as president of the Congress. Of the three Congresses that have been held previously, the first was in Madrid, in 1933; the second in Brussels, in 1936; the third in Atlantic City, New Jersey, U.S.A., in 1939. The State Department in Washington having approved of the International Cancer Research Congress, official invitations will shortly be sent to foreign governments. Dr. M. G. Seelig, Barnard Free Skin and Cancer Hospital, St. Louis 3, Mo., is chairman of the Publicity Committee of the Congress.

## An Optical-Acoustic Method of Gas Analysis

Mr. A. Whitaker, chief engineer of Ascot Gas Water Heaters, Ltd., Research Laboratories, Tolworth, Surrey, writes: "The instrument described by Dr. F. I. Callisen in *Nature* of February 1, p. 167, is being used in these laboratories. It is based on the description published by Dr. Luft-Oppau and has been further developed at our request by the Infra-Red Development Co., Ltd. A working model will be shown by Ascot Gas Water Heaters, Ltd., at the forthcoming Physical Society's Exhibition.

## Announcements

Prof. W. J. de Haas, professor of experimental physics and meteorology in the University of Leyden, and Sir John Russell, formerly director of Rothamsted Experimental Station, Harpenden, Herts, have been elected foreign associates of the Paris Academy of Sciences.

The Committee of Privy Council for the Organisation and Development of Agricultural Research has appointed Mr. James Turner, president of the National Farmers' Union, to be a member of the Agricultural Research Council.

Mr. J. F. Foster, formerly registrar of the University of Melbourne and secretary of the Australian Vice-Chancellors' Committee, has been appointed secretary of the Universities Bureau of the British Empire, on the retirement of Mr. W. B. Brander from that office. Mr. Brander, who has been secretary since 1930, will continue for a while in an advisory capacity.

Mr. N. F. Astbury has been appointed director of research to the Guest, Keen and Nettlefolds group of companies. Mr. Astbury was director of the Research Laboratories of Joseph Sankey and Sons, Ltd., one of the member firms of this group. It is intended that these laboratories shall now become the headquarters of the research organisation of the combine.

The Research Council of Alberta is offering two fellowships, each of value 1,320 dollars for one year, tenable at the Council's laboratories, University of Alberta, open to graduates in chemistry and chemical engineering. Applications should be sent by air-mail to the secretary of the Council, University of Alberta, as soon as possible.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Phenolic Substances Concerned in Hardening the Insect Cuticle

THE hardening of the protein of insect cuticles is due to the tanning action of an agent produced by oxidation of a phenolic substance[1]. The hardening of the cockroach ootheca (*Blatta orientalis*) is analogous to this process, and we have recently demonstrated that the phenolic substance responsible in this case is 3 : 4-dihydroxybenzoic acid (I) (protocatechuic acid)[2]. Not only was this acid isolated in substantial quantity from the oothecæ, but also it was found that an aqueous solution of synthetic protocatechuic acid in presence of oxygen produced the characteristic darkening effect of the secretion of the right colleterial gland of the female cockroach upon the protein secretion of the left gland. This study of the cockroach ootheca represented the initial phase of a more extensive investigation of the hardening process in insects ; as a next step it was decided to attempt the isolation of phenolic substances from other species, to find out whether protocatechuic acid is a general hardening agent or whether the agent varies from species to species. The investigation is far from complete but, particularly in view of the general interest in the problem of the insect cuticle and the recent publications of Dennell[3] and Fraenkel and Rudall[4], it is felt that the results so far obtained are worthy of record at this stage. The species examined were *Calliphora erythrocephala*, *Lucilia cæsar* (puparia) and *Tenebrio molitor* (adults), and the experimental procedure and results can be summarized as follows.

*Calliphora erythrocephala*. A stock of mature larvæ which had ceased to feed were kept at room temperature ; they were examined daily, and any puparia (whether darkened or not) were picked out and stored in water containing a little cyanide and sulphur dioxide. When about 100 c.c. of puparia had been collected, they were crushed and extracted with acidulated aqueous alcohol (20 per cent) until the extract showed no ferric reaction. The aqueous alcoholic extract was concentrated *in vacuo* and then extracted continuously with peroxide-free ether. The ethereal solution so obtained was treated with diazomethane, evaporated, ester groups hydrolysed with methanolic potassium hydroxide, and the final product recrystallized from water and sublimed at 100°/$10^{-1}$ mm. The acid isolated in this way had m.p. 178° and was identified as 3 : 4-dimethoxybenzoic acid (veratric acid) by direct comparison (m.p. and mixed m.p.) with an authentic specimen.

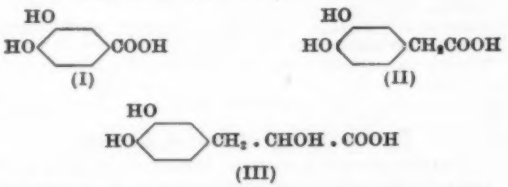
*Tenebrio molitor*. A stock culture was examined once a week and freshly emerged adults picked out and stored as above. When enough had been collected, the whole bodies were crushed and treated in the same way as the blowfly puparia. Two batches, collected from the same stock one after the other, were used ; the first contained about 2,000 and the second about 750 individuals.

(1) The product from the first batch, after hydrolysis of ester groups, was unexpectedly soluble in water but separated from benzene/light petroleum as colourless crystals, m.p. 94–96°. After several recrystallizations from the same solvent mixture a homogeneous substance was obtained, m.p. 104–105° (20 mgm.) (found : C, 58·0 ; H, 5·9. $C_{11}H_{14}O_5$ requires C, 58·4 ; H, 6·2 per cent). From the analytical results it seemed likely that this acid was the hitherto undescribed α-hydroxy-β(3 : 4-dimethoxyphenyl)-propionic acid (3 : 4-dimethoxyphenyl-lactic acid). Accordingly, 3 : 4-dimethoxypyruvic acid[5] was subjected to catalytic hydrogenation ; *dl*-α-hydroxy-β-(3 : 4-dimethoxyphenyl)-propionic acid so obtained (found : C, 58·3 ; H, 6·0. $C_{11}H_{14}O_5$ requires C, 58·4 ; H, 6·2 per cent) had m.p. 104°, undepressed in admixture with the acid isolated from *Tenebrio molitor*.

(2) The purified product (9·8 mgm.) from the second batch had m.p. 95–96°, undepressed in admixture with 3 : 4-dimethoxyphenylacetic acid (m.p. 95–96°)[6], but depressed by 3 : 4-dimethoxyphenyl-lactic acid. Further confirmation of its identity was provided by nitration ; the recrystallized nitrocompound formed needles, m.p. 209°, undepressed by 6-nitro-3 : 4-dimethoxyphenylacetic acid (m.p. 208°) synthesized by the method of Oliviero[7].

*Lucilia cæsar*. Extraction of *Lucilia* puparia (*c.* 500 c.c. collected as for *Calliphora*) with acidulated aqueous alcohol gave no material with a positive ferric reaction, and on working up the extract in the manner described above, the only crystalline product obtained was succinic acid (50 mgm.), identified by analysis, chemical properties, m.p. and mixed m.p. Extraction of the crushed larvæ with ether also failed to yield any phenolic material ; the unsaponifiable fraction of the ethereal extract contained, as crystalline constituents, a hydrocarbon (80 mgm.), m.p. 60–61° (found : C, 85·3 ; H, 14·9 per cent) and cholesterol (200 mgm.), identified by m.p., mixed m.p. and preparation of its acetate.

In the experiments above described, the phenolic acids present in the insect material were methylated with diazomethane in order to simplify working up, so that the products actually isolated were the corresponding methyl ethers. It is, however, clear that *Calliphora* puparia contain protocatechuic acid (I) and *Tenebrio* imagines 3 : 4-dihydroxyphenylacetic acid (II) and 3 : 4-dihydroxyphenyl-lactic acid (III). The presence of (II) in the elytra of the latter species has already been reported[8].




It would seem likely from the isolation of only 3 : 4-dimethoxyphenylacetic acid in one experiment with *Tenebrio* and of 3 : 4-dimethoxyphenyl-lactic acid in the other that, had larger amounts been available, both compounds would have been isolated in each case. Further work is required to settle this point and to establish whether any protocatechuic acid is present in the same insect. Fraenkel and Rudall[4] have shown that the substance responsible for the darkening of the blood after death is probably free tyrosine ; the first product of the action of polyphenol oxidase on tyrosine is probably dihydroxyphenylalanine, and it is interesting that the three phenolic acids so far detected by us represent a complete series of what would be the expected stable degradation products of the latter. It is, of course,

clear that the preliminary experiments here reported do not provide any answer to the obvious question whether, in *Tenebrio*, (II) or (III) themselves take part in the hardening process, or whether they are intermediate products in the conversion of 3 : 4-dihydroxyphenylalanine to protocatechuic acid, which then acts as hardening agent.

On the mechanism of the hardening process itself, we have as yet made only a few preliminary studies, and our results will be communicated at a later stage. It would, however, seem likely that it is brought about by the condensation of the oxidized *o*-dihydroxy acid with protein chains to form stable cross-linked structures in which the nitrogen originally present in free amino-groups becomes directly attached to the aromatic nuclei. Such a reaction, which would give structures resistant to the attack of hydrolytic agents, has its analogy in the well-known condensations of quinones with amines, and in particular that of *p*-benzoquinone with glycine[8]. This hypothesis appears to be in harmony with all the known facts about the hardening process.

The failure to detect any phenolic acid in the *Lucilia* larvæ examined is rather striking and requires further study. It may, however, be bound up with the fact that darkening of the puparium in *Lucilia* is slower, and the final colour paler, than in *Calliphora* or *Sarcophaga*, so that the hardening agent may only be present in very small quantity at any one time. The function of the considerable amount of succinic acid isolated is obscure, but it is probably derived from the larval blood, since it has also been isolated from the blood of *Gastrophilus* larvæ[10].

M. G. M. Pryor
P. B. Russell
A. R. Todd

Zoological Laboratory,
Chemical Laboratory,
University of Cambridge.
Feb. 7.

[1] Pryor, *Proc. Roy. Soc.*, B, **128**, 378, 393 (1940).
[2] Pryor, Russell and Todd, *Biochem. J.*, **40**, 627 (1946).
[3] Dennell, *Proc. Roy. Soc.*, B, **134**, 79 (1947).
[4] Fraenkel and Rudall, *Proc. Roy. Soc.*, B, **134**, 111 (1947).
[5] Kropp and Decker, *Ber.*, **42**, 1186 (1909).
[6] Kindler and Peschke, *Arch. Pharm.*, **271**, 431 (1933).
[7] Oliviero, *Gazz. chim.*, **65**, 143 (1935).
[8] Schmalfuss, Heider and Winkelmann, *Biochem. Z.*, **257**, 188 (1933).
[9] Fischer and Schrader, *Ber.*, **43**, 525 (1910).
[10] Private communication from Prof. D. Keilin.

## Permeability of Insect Cuticle

I have chanced to make an observation, at present unexplained, which may throw light on the properties of insect cuticle.

The leg of the cockroach (*Periplaneta americana*) is somewhat transparent, and it is easy to observe the main trachea through the cuticle. If one puts a drop of water on the exterior of the leg, just over this trachea, minute droplets appear almost instantaneously inside the trachea. In all cases the droplets appear only in that length of the trachea which is covered by the outer drop. These droplets later coalesce, and if the water drop on the outside of the leg is allowed to evaporate they eventually disappear.

The droplets do not wet the intima of the cuticle, and are judged to consist mainly of water. They appear in both the amputated and living leg; if, however, the trachea is collapsed by mechanical pressure, etc., this phenomenon does not occur.

Similar droplets were also observed with certain other liquids (acetic acid, benzene, ether, etc.), but they disappeared more quickly than in the case of water. Droplets, however, did not appear with glycerine.

The droplets which appear in the trachea might be due to cooling and condensation of water following evaporation of the drop on the surface or to some osmotic effect, if one could postulate penetration of liquid through the cuticle. Direct chilling of the leg failed to produce this phenomenon, but if a drop of water is placed on a chilled leg, droplets still appear in the trachea. In the latter case temperature is gradually rising, so there is no question of further chilling. Moreover, arguing on theoretical grounds, the amount of water appearing in about 1 mm. length of trachea is much more than can be accounted for even assuming that the air inside the trachea is 100 per cent saturated and all the water vapour condenses. To test the second possibility, distilled water, a series of salt solutions (from 0·7 to 1·5 per cent) and cockroach blood were tried. In each case the droplets appeared. It is evident, therefore, that the droplets are not due to physical or chemical differences between external liquid and tissue fluids.

The cuticle of *Rhodnius* is sufficiently transparent, and it is easy to observe the main trachea through the cuticle in the abdominal segments on the dorsal side. Droplets can be produced in it by applying water externally.

Rajindar Pal

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Jan. 24.

## Structures of Ethylene Oxide and *Cyclo*propane

The recent communication of Walsh[1] includes several statements which are open to question. The suggestion that the reactions of ethylene oxide are at present considered to be due to instability caused by ring-strain is not acceptable without qualification and explanation. Nobody, one hopes, still retains any purely mechanical idea of strain such as one finds in the springs of models. Nowadays reactions are universally attributed to the functions of electrons and nuclei, and an interpretation of the special reactivity of such a series as acetylene, ethylene, *cyclo*propane and *cyclo*pentane can surely be found by the application of quantum mechanical principles to the usual formulæ. These represent nothing more than the mode of linking of the atoms in the molecule, combined with an indication of the degree of symmetry of the statistical distribution of electrons. Thus we may be confident that the ring-binding in *cyclo*propane has the symmetry of an equilateral triangle, that in ethylene oxide of an isosceles triangle, and that of propylene oxide of a scalene triangle. The usual formula for *cyclo*propane is therefore as satisfactory a symbol as can be devised.

The statement that trimethylene oxide is less stable than ethylene oxide is surely incorrect. Is this a case of the old confusion between stability (or reactivity) and ease of formation?

Again, the reactions of ethylene oxide are not to be compared with those of ethylene as stated by Walsh; they are, however, very similar to those of acetaldehyde. Under ordinary conditions of tem-

perature and pressure, the olefines are anionoid in the first phases of reactions, whereas the aldehydes and ketones, and also the olefine oxides, are cationoid. That is, a reaction of ethylene is normally initiated by electron donation; a reaction of ethylene oxide by electron acceptance. The case of reaction with acids is exceptional in that a proton is probably first taken up by the non-bonded oxygen electrons, and in the resulting complex the oxygen–carbon link possesses enhanced cationoid character.

The claim that the conception of electron donation by bonding electrons is novel can be admitted only if it is limited to such new structures as those now proposed for ethylene oxide and *cyclo*propane. As a stage in reaction mechanism the idea can be traced back to Kekulé, whose theory of the formation of additive complexes and their redistribution can only be translated in modern terms by the use of reactive bonding electrons. If it were otherwise, saturated compounds could undergo no chemical transformations. Although it is true that a proton can often be regarded as a point of entry into the molecule, yet it is not difficult to find cases where the activity of a covalent link, carbon to carbon, should be assumed. For example, in 1916 I postulated[2] the conjugation of the unsaturation of *cyclo*propane and *cyclo*butane rings with an ethenoid group, and gave as an example of conjugated addition to such a system the formation of pinene hydrochloride, which occurs with intramolecular rearrangement.

As a written symbolic expression, the formula (I) for ethylene oxide appears to be quite unsatisfactory. As pointed out by Walsh, (I) shows an analogy with the amine oxides, but the behaviour of ethylene oxide does not support the implications. There is, no doubt, a small dipole moment, but not that expected of a molecule containing $\rightarrow O^-$. The amine-oxides are easily reduced to amines; ethylene oxide is not reduced to ethylene but rather to ethanol, and that with no great ease. The very natural extension to the azoxy compounds would be incorrect. These substances cannot be formulated as (III); they have been proved to be (IV).

| $CH_2{=}CH_2$ | $CH_2{=}CH_2$ | $-N{=}N-$ | $-N{=}N-$ |
|---|---|---|---|
| ↓ | ↓ | ↓ | ↓ |
| O | $CH_2$ | O | O |
| (I) | (II) | (III) | (IV) |

The formula (II) for *cyclo*propane is still less satisfactory. It does not express the symmetry of the molecule, and an attempt to achieve this by writing two other formulæ alongside would be nothing more than an admission of that degree of symmetry and in effect a reversion to the accepted structure.

What we need here is not new formulæ to set down on paper, but an explanation on quantum mechanical principles of the degree and quality of reactivity exhibited by assemblages of nuclei and electrons having the overall or average symmetry and spatial arrangement indicated by the usual structures and models. The overlapping of the orbitals would appear to supply this without the necessity for writing new constitutional formulæ.

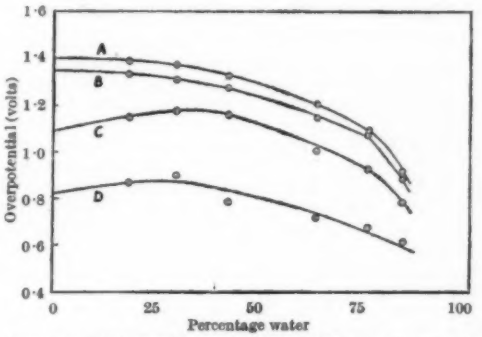
R. Robinson

Dyson Perrins Laboratory,
University, Oxford.
Feb. 10.

[1] Walsh, *Nature*, **159**, 165 (1947).
[2] Robinson, *J. Chem. Soc.*, **109**, 1042 (1916).

## Effect of the Solvent on Oxygen Overpotential

Recent work on the effect of the solvent on the hydrogen overpotential[1] has proved a fruitful source of evidence on the relative probability of the various suggested slow stages in the reactions at the cathode during the electrolytic evolution of hydrogen. No corresponding evidence seems to be recorded for the solvent effect on the oxygen overpotential, concerning which the following is a preliminary report. Few media are available for such experiments owing to anodic oxidation: aqueous acetic acid and aqueous dioxane were chosen for their suitable properties in this respect.




Curve *A*: $10^{-1}$ amp./sq. cm.; *B*, $5 \times 10^{-2}$ amp./sq. cm.; *C*, $10^{-2}$ amp./sq. cm.; *D*, $10^{-3}$ amp./sq. cm.

Measurements have been carried out on smooth platinum anodes in a series of aqueous – non-aqueous mixtures containing these solvents, over a current density range of $10^{-3}$–$10^{-1}$ amp. sq. cm. The effects of both non-aqueous components are similar. The overpotential increases at first rapidly and then with decreasing slope upon increase of non-aqueous content (see graph). The Tafel equation ($\eta = a + b \log I$, where $\eta$ is overpotential, $I$ is current density, and $a$ and $b$ are constants) is approximately applicable in all systems; the values of $b$ are all greater than in water. The increase in overpotential with time of polarization and the 'long-time' decay of overpotential after cessation of the polarizing current are not essentially affected by the solvent.

These results are not in accord with the slow discharge theory of Erdy-Gruz and Volmer[3], according to which possible solvent effects would be expected to depend primarily upon changes in the solvation energy of the $OH^-$ ion; it seems very probable that this remains approximately constant in the systems examined[3]. From Eyring, Glasstone and Laidler's prototropic transfer theory[4], it seems logical to argue that presence of the non-aqueous component would serve to break up the continuous structure of solvent molecules bound to the anode and thus facilitate transfer of hydrogen atoms from the electrode to the solution layer. The overpotential would, therefore, be expected to be lower in aqueous – non-aqueous than in aqueous media, which is the reverse result to that found. Interpretation of the present experiments follows clearly from the assumption of the retardation of the heterogeneous combination of oxygen atoms caused by the presence of the non-aqueous component attached to the anode. It is assumed that both solvent components are adsorbed, but that, owing to steric factors, acetic acid and

dioxane molecules exert a greater poisoning effect on the reaction velocity than water.

A fuller account of this work will be published elsewhere.

J. O'M. Bockris
Imperial College of Science and Technology,
London, S.W.7. Jan. 16.

[1] Hickling and Salt, *Trans. Faraday Soc.*, **37**, 224 (1941). Bockris, *Nature*, **158**, 584 (1946) and in the press. Bockris and Ignatowicz, in the press.
[2] *Z. phys. Chem.*, **165**, 53 (1932).
[3] Butler and Thompson, *Proc. Roy. Soc.*, A, **141**, 86 (1933).
[4] *J. Chem. Phys.*, **7**, 1053 (1939).

## Spread Around the Initiating Point of the Detonation Wave in High Explosives

THERE is an old belief that the detonation wave in an explosive must travel a certain distance from the initiating point before attaining its final speed. In order to elucidate this problem, cylindrical charges of pressed T.N.T. have been fired with the detonator in different orientations and at various distances from the end surface of the charge. During experiments the flame was photographed on a film running with a constant speed of about 100 m./sec. Between the charge and the camera a screen with a vertical slit, 5 mm. wide, was fitted 1 m. from the charge. In all cases the axis of the charge was horizontal and pointed at the camera.

The charges with the dimensions 99·8 mm. × 99·8 mm. were initiated by electric detonators No. 8 from Imperial Chemical Industries Ltd. The priming charge consisted of a lead azide–lead styphnate mixture (0·22 gm.), and the base charge, 18 mm. long, of tetryl (0·688 gm.). The diameter of the detonator was 6·8 mm. and of the hole in the charge 7·2 mm. The centre of the free end surface of the detonator was placed at various distances, denoted $d$, from the photographed end surface of the charge. The axis of the detonator coincided in

*Case* 1 with the axis; depth of the hole for detonator: 99·8-$d$ mm.
*Case* 2 with a horizontal radius } depth of hole:
*Case* 3 with a vertical radius } 62 mm.

A typical photographic record is reproduced in Fig. 1. The time axis is a horizontal line assumed to

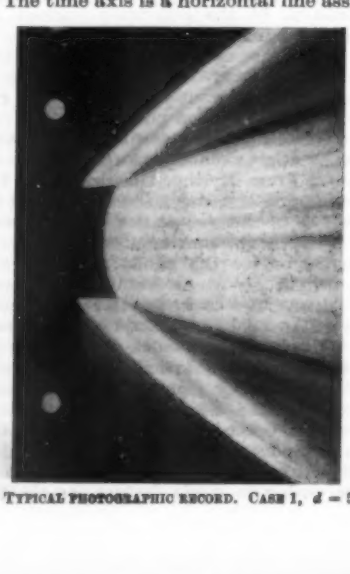


Fig. 1. TYPICAL PHOTOGRAPHIC RECORD. CASE 1, $d$ = 59·5 MM.

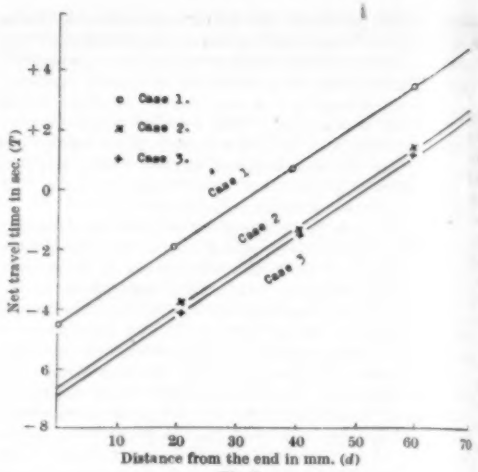



Fig. 2

lie at equal distances from the points of the two protruding horns, which mark the arrival of the detonation wave at the upper and lower intersections between a vertical line through the initiating point and the cylindrical surface of the charge. A relative displacement in the time direction of the horns indicates a vertical excentricity of the initiating point. Zero time is the point where a line through the points of the two horns intersects the time axis.

The curved front between the horns shows how the detonation wave successively reaches the end of the charge. A vertical tangent to this front marks on the time axis the travel time to the end surface after deducting the travel time to the cylindrical surface.

The relation between this net travel time, $T$, and the distance, $d$, in the three cases is as shown in Fig. 2. In all cases the curves are straight lines with the same slope. Hence it may be concluded that the detonation is propagated with a uniform speed in all directions from the detonator.

For any distance $d$ the difference between the travel times in Case 1 and Case 2 is about 2·1 μsec., which with due consideration of the detonation velocity of tetryl places the initiating point about 18 mm. from the free end of the detonator or almost exactly on the contact surface between the priming and the base charge. The small time difference (0·2 μsec.) between the lines of Case 2 and Case 3 may probably be explained by the fact that the depth of the hole for the detonator should have been 68 mm. instead of 62 mm. to get the initiating point exactly on the axis of the charge.

The slope of the lines corresponds to a wave-speed of 7,470 m./sec., which is 10 per cent higher than the generally accepted value 6,800 m./sec. for T.N.T. The discrepancy probably lies in the loss of speed when using built-up charges, as may be usual in routine tests. This question will be more thoroughly discussed elsewhere.

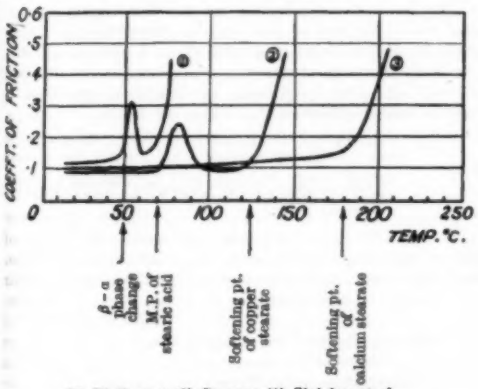
The camera was constructed and built by the Försvarets Forsknings Anstalt (FOA 2), who kindly placed the camera and some of their experts at our disposal.

WALODDI WEIBULL
Physical Research Department,
AB Bofors, Bofors, Sweden.
Jan. 27.

## Lubricating Properties of Molecular Layers of Stearic Acid and Calcium Stearate on Metal Surfaces

FOLLOWING the work of Bowden, Gregory and Tabor[1], we have made friction-temperature measurements on mono- and multi-layers of calcium stearate and stearic acid on various metals. These authors stated that for each metal the transition from smooth to stick-slip sliding and a rise in the friction occurred at the melting or softening point of a surface film of metal soap produced by reaction with the fatty acid. It seemed, therefore, that in mixed films of soap and acid there should be fluctuations in the friction curve corresponding to the melting points of the substances present.

We deposited molecular layers of calcium stearate and stearic acid on copper, platinum and stainless steel by the Langmuir–Blodgett method[2] from a $10^{-4}$ molar solution of calcium carbonate. At *p*H 6 these layers contain 60 per cent soap and 40 per cent acid[3]. We used the Bowden – Leben friction apparatus to study the frictional behaviour.




(1) Platinum; (2) Copper; (3) Stainless steel

The temperatures at which changes in friction occurred corresponded closely to known physical changes of the layer substance in bulk (see graph and table).

| Metal | No. of monolayers | Transition temperature (° C.) | Remarks |
|---|---|---|---|
| Platinum | 1 | No lubrication | |
| | 3 | 20–25 50–60 | β to α transformation at 54° C. M.P. stearic acid, 69° C. |
| | 5 | 40–45 70 | |
| | 7 | 45–55 75–85 | |
| | 9 | | |
| Stainless steel | 1 | 150–160 | Softening point calcium stearate, 180° |
| | 3 | 170 | |
| | 4 | 170–190 | |
| Copper | 1 | No lubrication | |
| | 3 | 70 125 | M.P. stearic acid, 69°. Softening point copper stearate, 125° |
| | 7 | 70 125 | |
| | 9 | 70 125 | |
| | 21 | 70 125 | |

With copper surfaces there are two fluctuations. The first, at the melting point of stearic acid, is not permanent and is thought to be due to the melting of the stearic acid, which, when liquid, is able to react with the surface, forming solid copper stearate. The friction then falls to its original low value and continues so until the softening point of copper stearate (125° C.), above which temperature a permanent increase in friction occurs.

On stainless steel no frictional changes occur at the melting points of stearic acid or ferric stearate (100–125° C.), but there is a transition at the softening point of calcium stearate (180° C.). With platinum, a fluctuation occurs below the melting point of stearic acid. Similar fluctuations are observed with palmitic and octacosanoic acids on platinum at 45° C. and 80° C. respectively. These temperatures are very closely similar to the temperatures at which β, α phase changes were observed in X-ray studies of monolayers of these acids on gold surfaces by Dupré la Tour[4]. It appears that the friction change is related to this phase transformation. There is also, as with copper, a sharp rise in friction at the melting points of the acids; but since no reaction can take place, no subsequent recovery occurs.

In general, each fluctuation corresponds to a softening or melting point of one of the constituents of the lubricating layer; but the frictional effects, and the number of layers required for lubrication, depend considerably on the nature of the underlying metal. Calcium stearate does not appear to lubricate copper and platinum, since with a mixed film, final breakdown of lubrication occurs at the same temperature as when pure stearic acid is spread on the surfaces[5]. Yet calcium stearate appears to lubricate stainless steel up to its melting point. This anomaly may be related to the fact that it requires only one molecular layer to lubricate steel compared with the three and five layers for copper and platinum respectively.

It is hoped that future work with an electron diffraction camera will give more information on these points.

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Dec. 24.

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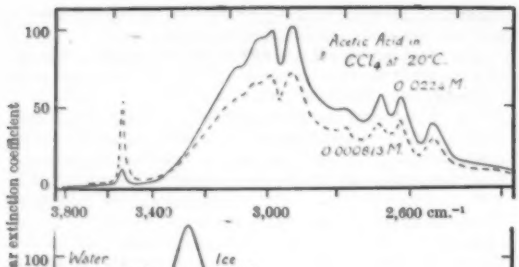
## Hydrogen Bonding in Ice

IN a recent communication in *Nature*[1], Prof. Max Born has discussed some features of the Raman spectrum of ice, more particularly in relation to the elastic constants. Since Prof. Born makes no use of the available infra-red measurements on ice[2] or of some earlier work on certain aspects of hydrogen bonding in ice, it seems worth while to recall some relevant data:

(1) Frequencies at 205–210 and 601 cm.$^{-1}$ occur in the Raman spectrum of ice[3,4] (calculated as 172 and 718 cm.$^{-1}$ by Prof. Born from the elastic constants of ice) and are also found in liquid water[3,4,5] less sharply defined at $\sim$ 175 and $\sim$ 500 cm.$^{-1}$. The lower frequency has for some years been identified as a hindered translation, and the higher as a hindered rotation or libration of an isolated water molecule in the surrounding water (or ice) structure. Bernal and Tamm[6] estimated these frequencies as 170 and 480 cm.$^{-1}$ in ice, and used them to calculate the specific heat of ice at the melting point.







(2) The broad Raman band of ice extending from 3,000 to 3,600 cm.$^{-1}$ is quite similar to the corresponding infra-red band (see accompanying graph), and both are generally regarded as being derived from the O—H vibrational frequencies in single molecules (3654 cm.$^{-1}$ in the Raman spectrum and 3,756 cm.$^{-1}$ in the infra-red spectrum), the parent frequency being reduced to a greater or lesser extent as a result of the influence of surrounding molecules in the liquid and solid states. Prof. Born appears to dislike this explanation; but the effect is quite characteristic of hydroxylic bodies generally (alcohols, phenols, carboxylic acids), and in each case the sharp O—H band observed for the monomeric substance becomes blurred, with a somewhat lower average frequency and greatly increased intensity of absorption as soon as association takes place. There is good evidence from infra-red measurements that the change of frequency from O—H (monomer) to O—H (polymer) is a measure of the strength of the hydrogen bond[7]; for example, when ice melts there is a shift of the O—H band to higher frequencies (see graph) corresponding to a reduction in the degree of association, and this effect continues steadily as the temperature of the water is increased.

A case of hydrogen bonding of considerable interest is afforded by acetic acid dissolved in carbon tetrachloride (see graph). The monomeric O—H band is clearly observed at 2·83 μ (3,534 cm.$^{-1}$), and rapidly diminishes with increasing concentration while the broad association band increases. The nature of the association between carboxylic acid molecules is established from electron diffraction measurements on formic acid[8]; the molecules are supposed to be associated in the form of a ring dimer

$$R-C\begin{matrix}O-H\ \ldots\ O\\ C\ \ldots\ H-O\end{matrix}C-R$$

with an O—H . . . O separation of 2·67 A. At low concentrations the rings split up into single molecules, and an equilibrium is set up

$$R.COOH+R.COOH \rightleftarrows 2(R.COOH).$$

The difference between the association in ice and in acetic acid dissolved in carbon tetrachloride, as shown in the graph, is very marked, and clearly develops at very low concentrations in the latter case, due presumably to the stabilizing effect of the compact ring structure as compared with the less well-defined water complexes. The maximum possible effect on the O—H frequency of acetic acid as a result of hydrogen bonding would be obtained when the hydrogen atom occupies a mid-way position between two competing oxygen atoms, and in these circumstances the O—H distance would be approximately 1·335 A. instead of about 1 A. in the single acid molecules. A rough calculation shows that the frequency to be expected in this extreme case is ~2,330 cm.$^{-1}$ (~4·3 μ), and the curve shown does indicate a limiting value approaching this. No such extreme value is, however, found in ice, and the comparatively small frequency shift observed in this substance must mean that the average O—H distance is not greatly changed from the normal value in single molecules. A rough calculation indicates an average extension of the O—H bond in ice of perhaps 5 per cent.

(3) Prof. Born states that there is no line in the Raman spectrum of ice in the region between 800 and 2,900 cm.$^{-1}$; this is incorrect, as there is a Raman line at 2,225 cm.$^{-1}$ in ice at 0° C.[3]. The corresponding infra-red frequency is 2,222 cm.$^{-1}$ in ice at 0° C., while the values for water at 0° C. are ~2,170 and 2,149 cm.$^{-1}$, respectively. This frequency has been interpreted as a combination of the deformation frequency $\nu'_2$ (~1,650 in ice and water) and the frequency of hindered rotation $\nu_R$ previously mentioned[2,9]. Thus we have

$\nu'_2+\nu_R = 1{,}644+601=2{,}245$ for ice (2,222 observed)

and

1,646 + 500 = 2,146 for water (2,128 observed at 21° C.).

The ~2,150 cm.$^{-1}$ frequency in water (4·7 μ band) has a particularly strong temperature dependence, and this is attributed to the naturally large variation of $\nu_R$ with temperature.

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Jan. 11.

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[3] Hibben, *J. Chem. Phys.*, **5**, 166 (1937).
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[5] Magat, *J. Phys. Radium*, **5**, 347 (1934).
[6] Bernal and Tamm, *Nature*, **135**, 229 (1935).
[7] Fox and Martin, *Trans. Faraday Soc.*, **36**, 897 (1940).
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[9] Ellis, *Phys. Rev.*, **38**, 693 (1931).

## Low-Pressure Electrical Discharges

Some experiments awaiting publication show how remarkably easy it is to start high-frequency electrodeless discharges at pressures of the order of 1/100 or even 1/1,000 mm. of mercury in a uniform electric field. For a bulb of given size, the wave-lengths must be less than a certain value which is directly proportional to the diameter of the bulb. A rough working rule is that the maximum permissible wave-length (measured in metres) is four times the diameter of the bulb (measured in centimetres). If the pressure inside the bulb is increased from the above small value, this 'cut off' wave-length is also increased, and at a still higher pressure the 'cut off' disappears. At wave-lengths beyond the 'cut off' enormous voltages are required to get a discharge—if one can be got at all. The discharge starts most easily for wave-

lengths from about one half to three quarters of the 'cut off' wave-length.

Provided the bulb is in a fairly uniform field (which is produced well enough by using circular parallel plates of diameter about one and a half times the bulb, with the bulb in between and close to both) a very moderate voltage will start the discharge. A peak value of the order of 100 volts will suffice whatever the size of the bulb if the above appropriate wave-lengths are used. When the discharge has once started, a peak value of considerably less will maintain it. All the power required can be got from a high-frequency generator running on 40–50 watts.

The most interesting fact is that the starting potential at these low pressures is independent of the nature of the gas, however carefully it is purified. Helium, hydrogen, air and mercury were used in bulbs varying from 3 cm. to 20 cm. in diameter, or flat-ended tubes a few centimetres long.

It follows that, at any rate initially, the large increase in the number of the few electrons present, necessary to start a discharge, when the high frequency is applied, cannot be due to gas ionization alone. The only other possibility of increase is secondary emission from the glass, and taking this as the main factor a simple theory is in good agreement with the main experimental results and with secondary emission data given by Bruining[1].

Additional confirmation was the fact that if the glass surface is varied, the starting potentials are altered, in some cases very considerably. The theory was based on five simple considerations: (1) The velocity of electron impact on the glass has to be sufficient for each primary on the average to liberate more than one secondary. (2) The secondaries have a small emission velocity. (3) The phase has to be such that the secondaries cross the tube and are not pulled back by the alternating field to the glass from which they came. (4) That for constant increase in numbers this process must be repeated exactly every half-cycle. (5) That the electron velocities necessary to satisfy the above conditions are quite sufficient to ionize readily any gas by a collision.

The work was assisted by a grant from the Department of Scientific and Industrial Research.

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A. von Engel

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University, Oxford. Feb. 1.

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## Micro-Wave Solar Noise Observations During the Partial Eclipse of November 23, 1946

During the partial eclipse of the sun on November 23, 1946, a record of the reduction of radio-frequency energy emitted from the sun in the 2800-megacycle band was obtained at Ottawa, Canada. At this station, the eclipse commenced at 10.45.5 E.S.T., reached a maximum at 12.18 and ended at 13.51. At noon the sun was at an altitude of 23°, with its axis of rotation 19° east of north. The clear sky permitted the taking of photographs of the sun at the Dominion Observatory. Data from these are shown in Fig. 1.

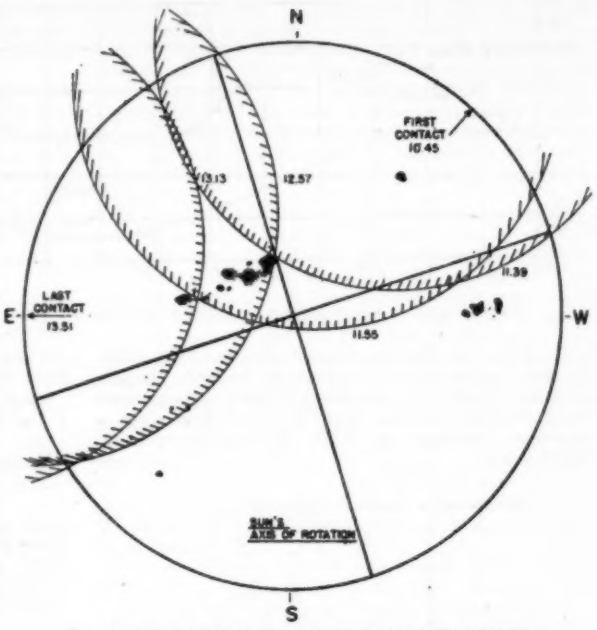


Fig. 1. Lunar shadow positions outlining active region. Data from Dominion Observatory photographs

The sun's radiation, contained in two 5-megacycle bands centred about 2800 megacycles, was continuously received by a parabolic reflector, astronomically mounted and driven to follow the sun. Once every hour the drive was corrected manually to compensate for errors in following. The dipole antenna placed at the focus of the mirror was oriented so that its axis was parallel to the sun's axis of rotation; thus the plane of polarization of the received energy was fixed with respect to the sun's axis. The beam-width, 6° to the half-power points, allowed the total radiation from the sun and surrounding space to be received. The receiver, constructed after the manner of Dicke[1], measured over a short period of time the relative changes of energy to within 1 per cent. For a longer period of time, the sensitivity showed a gradual change. Calibration with a thermal load before and after the eclipse showed that the receiver sensitivity had decreased by 12 per cent. In allowing for this drift, it was assumed that the change was linear with time. At times shown by breaks in the record (Fig. 2), the antenna was moved from the sun in order to obtain the background as a reference point. The receiver output was used to drive a recording milliammeter.

Curve *A*, Fig. 2, shows the percentage antenna temperature smoothed to eliminate receiver noise and corrected for changes in sensitivity; curve *B* shows the percentage eclipsed area of the sun's photosphere. The observational results are: (1) a 15 per cent rise in the sun's temperature after the end of the eclipse; (2) small temperature fluctuations of about 7 per cent before the eclipse; (3) (*a*) a definite drop 3·0 min. before the moon made its first visible con-

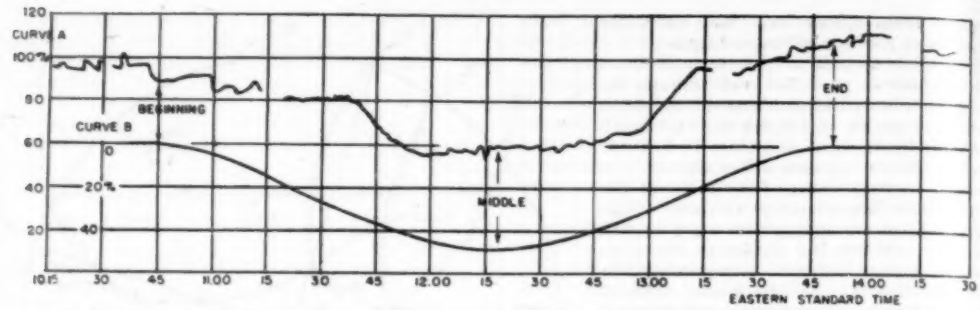


Fig. 2. Curve *A*, variation of solar noise during eclipse, November 23, 1946. Curve *B*, eclipsed area of sun

tact. At this instant the moon's edge was 1·05 times the sun's radius from the centre of the sun. Details of change are shown in the table below; (*b*) a gradual return during the last part of the eclipse; (4) a decrease occurring at 11.39 and an increase at 12.57 E.S.T.

| Minutes before contact | Percentage reduction |
|---|---|
| 3 | 0 |
| 2 | 4·8 |
| 1 | 6·5 |
| 0 | 8·0 |
| −1 | 9·5 |
| −2 | 9·5 |

Since the discovery of solar noise by Southworth[2] and Reber[3], and the subsequent discovery by Pawsey, Payne-Scott and McCready[4] that the sunspot areas are particularly active noise generators in a lower-frequency region (about 200 megacycles), records obtained during a solar eclipse will give information regarding the noise distribution over the sun's surface. In the microwave region (24,000 megacycles) reference should be made to the results of Dicke and Beringer[5] obtained during the eclipse of 1945. Fortunately, during the present eclipse, a large group of spots was obscured by the moon at 11.39 and uncovered at 12.57. It is believed that this is the interpretation of the sudden change of energy (25 per cent) during the middle of the eclipse marked by the fall and rise at the times indicated. The noise-generating region, totalling 2·2 per cent of the sun's projected surface and containing the sunspot group, is outlined by the four lunar shadows shown in Fig. 1. With the present data, this area has an equivalent temperature of $1{\cdot}5 \times 10^{6}$° K. in excess of the average surface temperature of $5{\cdot}6 \times 10^{4}$° K. This average is obtained for the eclipsed portion of the sun disregarding the spot area.

Before the first contact, the substantial reduction in energy might indicate that the source is in the space surrounding the sun, either from the corona or from a prominence. Calculation of the equivalent temperature of the crescent-shaped area swept out by the moon during the three minutes before contact gives $3 \times 10^{6}$° K. From the rate at which the temperature fell, most of the energy is produced in a region just off the visible limb. Photographic evidence for such a local disturbance has not yet been obtained.

No obvious correlation has been obtained between the disappearance of the isolated spot in the north-east quadrant of the sun and any sudden drops in radiation. The large group south of the equator was not eclipsed, although an active region surrounding this spot could have been partially eclipsed for a short time.

I much appreciate the assistance given by members of the Dominion Observatory.

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National Research Council,
Ottawa.
Dec. 16.

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[3] Reber, G., *Astrophys. J.*, **100**, 279 (Nov. 1944).
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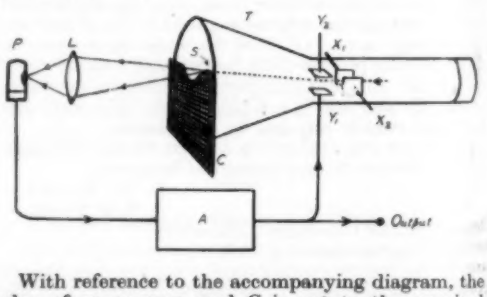
## A High-Speed Electronic Function Generator

Electronic 'analogue' computing circuits (in which electrical quantities such as voltage represent the variables involved) can perform many mathematical operations at such speeds that an upper limit may be set by the design of 'input table' employed. A device capable of reproducing a given wave-form repeatedly at high speeds has been described recently[1], and it is thought that some details may be of more general interest.




With reference to the accompanying diagram, the edge of an opaque card *C* is cut to the required shape, and the card placed over the face of a cathode-ray tube *T*. A lens *L* focuses light from the spot *S* on a photocell *P*, the output of which is coupled through an amplifier *A* to one of the deflector plates of the tube $Y_1$, in such a sense that an *increase* in the intensity of light would deflect *S towards* the region of the screen obscured by *C*.

Given suitable optical shielding and sufficient overall gain, *S* will be constrained to adopt a position partially obscured by *C*, and will follow the curved edge of *C* if subjected to *X*-deflexion. (It must be noted, however, that the persistence of screen after-

glow corresponds to an integrating term in the feedback loop, setting an upper limit both to the frequency response and to the gain of $A$ in accordance with Nyquist's criterion of stability[2].

If $y = F(x)$ be the equation of the curved edge relative to the *deflexion axis*, this will also (very nearly) be the equation of $S$, so that if $S$ be deflected linearly with time in the $X$-direction, the output wave-form will be an electrical replica of the curve. More precisely, if the co-ordinates of $S$ are $(x, y)$, and voltages on the $Y_1$, $Y_2$, $X_1$, $X_2$ plates are $p$, $q$, $r$ and $s$ respectively, we have

$$p - q = \frac{y}{k_1}; \quad r - s = \frac{x}{k_2},$$

where $k_1$ and $k_2$ are normally constant, being inversely proportional to the accelerating voltage $V$ of the tube. Hence the output voltage $p$ will obey the law $p = q + \frac{1}{k_1} \cdot F[k_2(r - s)]$, where $q$, $r$ and $s$ (and to a limited extent, $k_1$ or $k_2$) are independent variables, and $F$ can include rotation and displacement of the axes to which the curve was originally drawn.

Since one can also set either $r$ or $s$ equal to $p$ or $q$, the device is capable of generating quite a variety of functions, at a speed limited only by the frequency response of the system, conditioned mainly by the type of screen employed. Special screens are available with afterglow times of the order of microseconds, so that a 'scan time' of the order of milliseconds is feasible, and virtually continuous cathode-ray tube presentation of the output of a differential analyser using such a device should be possible, with obvious advantages when dealing with, for example, equations having variable coefficients. Other obvious possibilities are suggested by the ease with which functions such as $\log x$, $e^x$, etc., can be generated, and are at present being investigated.

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Jan. 27.

[1] Brit. Prov. Pat. Spec. No. 36849, 1946.
[2] Nyquist, *Bell System Tech. J.* (January 1932).

## Latent Energy and After-glow in Flame Gases

THE energy present in long-lived latent form in flame gases resides, I think, in very stable abnormal triatomic molecules formed during combustion. The amount of latent energy in flame gases resulting from combustion at constant pressure is rarely less than about 15 per cent of the heat of combustion, and, if this view is correct, the numbers of abnormal molecules must be large.

It has been suggested, by way of criticism of this, that the luminosity (after-glow) of flame gases indicates that there can only be an exceedingly small concentration of excited molecules. But this suggestion fails to account for the remarkable persistence of the after-glow in all cases where cooling of the flame gases does not take place rapidly. The numerous flame photographs taken by various observers show this clearly[1], and to the eye, of course, it persists for much longer than the photographs indicate. Indeed, after the explosion of a perfectly mixed inflammable mixture in a large vessel, it has been seen to exist for 14 sec., and there seems to be little doubt that were it possible to isolate hot flame gases away from surface, and under conditions such that cooling did not take place, it would remain for a time which could be measured in minutes. Furthermore, flame gases after being cooled to darkness by adiabatic expansion can be made luminous again by adiabatic compression[2].

It does not seem to be possible to account for the persistence of the after-glow unless it is assumed that large numbers of abnormal molecules of great stability are formed during combustion (just as was inferred from latent energy measurements), and that the *rate* at which these molecules reach the ground-state is exceedingly small. Individual molecules would not appear to possess sufficient energy for the emission of light quanta, and it seems probable that this can only happen during the infrequent collisions of sufficiently energized pairs of them. The rate at which such collisions take place, and therefore the intensity of the after-glow, depends both upon the concentration of the abnormal molecules, which varies with the amount of latent energy, and upon the flame gas temperature. This is in accord with experiment[3].

The hypothesis outlined above may also serve to explain the continuous background observed in carbon-monoxide and hydrogen flame gas spectra.

There is, I think, now no doubt that even in ordinary open flame gases some 25 per cent of the heat of combustion is in the form of latent energy and the abnormal dissociation[4] which results from it. This energy is released when the flame gases impinge upon surface.

It is hoped to publish shortly the evidence for this.

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[1] See, for example, Ellis and Wheeler, *J. Chem. Soc.*, plate v, p. 318 (Feb. 1927).
[2] *Phil. Mag.*, **9**, 399 (1930).
[3] *Nature*, **155**, 273 (1945).
[4] *Proc. Inst. Mech. Eng.*, **151**, 236 (1944).

## "Turbulent Flow in Alluvium"

SIR CLAUDE INGLIS, in his letter published in *Nature* of October 19, p. 552, remarks that my formulæ for alluvial flow are based on two fundamental relationships. It would be more correct to state that two independent fundamental equations are necessary to a complete solution, and that each of these equations consists of an empirical correlation of dimensionless numbers or 'arguments', derived from the essential variables. Dr. White has produced a partial solution, which effectively ignores the Reynolds number. The following solution appears to be complete.

There appear to be seven essential variables involved, namely:

| | | | |
|---|---|---|---|
| $P$ | wetted perimeter | $\mu$ | viscosity of water |
| $R$ | hydraulic mean depth | $g$ | acceleration due to gravity |
| $V$ | mean velocity | | |
| $\rho$ | density of water | $i = gRS$ | energy gradient |

These are the traditional variables. It will be observed that the density, grade and quantity of the

charge do not enter within this framework. They are implicit in the values assumed by $V$, $R$ and $S$ for a given value of $Q$ the discharge. These seven variables demand the following four dimensionless arguments :

$$V^2/gRS\,;\ V^2/gR\,;\ RV/\mu\,;\ P/R,$$

in which the slope $S$ has been inserted by substitution.

Of these four arguments any one may be expressed as an empirical function of any two of the remaining three. Two equations thus afford a complete solution, and they may be written :

$$P/R = \tfrac{1}{4}\,(V^2/gR)^{1/3}\,(RV/\mu)^{1/3} \qquad (A)$$
$$V^2/gRS = \tfrac{1}{4}\,(V^2/gR)^{-2/3}\,(RV/\mu)^{1/3}. \qquad (B)$$

These two equations reduce to

$$P = 2{\cdot}78Q^{1/3},$$

and

$$V = 15{\cdot}8R^{2/3}\,S^{1/3},$$

when the temperature of the water is 30° C.

The coefficients $\frac{1}{4}$ and $\frac{1}{4}$ respectively in the two basic equations appear to be pure numbers under ideal conditions.

On elimination of the Reynolds number from the basic equations, my equation published in *Nature* of August 3, p. 166, immediately results, namely :

$$V^2/gRS = \tfrac{1}{4}\,(gR/V^2)\ .\ P/R = \tfrac{1}{4}\ gP/V^2. \qquad (C)$$

The manner in which the three arguments enter should be noted. The new Froude number $V^2/gP$ is none other than the usual Froude number $V^2/gR$ divided by the shape number $P/R$. Similarly the 'White' number $ag^{2/3}/Q^{4/3}$ raised to the fifth power is none other than $P/R\ .\ (gR/V^2)^2$.

It would appear desirable, when making an attack on any dimensional problem, to express the new dimensionless numbers involved, if possible, in terms of more familiar dimensionless arguments. When this is done, the precise nature of the assumptions made is more readily appreciated.

The difficulties experienced in the past in the dimensional treatment of alluvial channels in loose material have arisen from the fact that the full implications of an ideal self-generating channel have not been understood. Old methods have been employed to solve a new problem. The reappearance of the old familiar dimensionless arguments, or numbers, is, however, reassuring.

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## Submarine Tubes for Levelling

THE ocean surface deviates from the geoid, that is, from a level surface, by an amount probably exceeding one metre even if short-period disturbances such as waves and tides are eliminated. It therefore cannot serve as a datum for precise levelling. Coasts separated by water can, however, be joined by hydrostatic levelling, recently described by Nørlund. In 1938 he 'bridged' the Store Belt[1] in Denmark with a water-filled submarine tube of length 18 km. and inside diameter 1 cm. ; the greatest depth was 60 m. Observations of atmospheric pressure at each end and of temperature distribution along the tube served to determine the difference in level between the water surfaces inside each end. In 1939 he joined the spirit-level networks of Denmark and Sweden by means of a 4·2 km. submarine tube beneath Oresund[2].

Nørlund's new method can furnish information needed in physical oceanography. The relations between current and slope of the ocean surface, except the part due to difference in atmospheric pressure, are the same as the more widely known relations between wind and slope of an isobaric surface in the atmosphere. Previous knowledge about the level or geopotential of the ocean surface has depended entirely upon the spirit-level method and the oceanographic method. The latter method gives the difference in geopotential between point 1 and point 2 in the form

$$\varphi_2 - \varphi_1 = -\int_{p_1}^{p_2} \alpha\ dp\,;$$

the integral of specific volume $\alpha$ with respect to pressure $p$ from point 1 to point 2 must be carried out along an instantaneous path consisting only of (*a*) vertical lines, and (*b*) lines along which the horizontal component of the pressure gradient vanishes. The distribution of specific volume is obtained by ordinary oceanographic methods. The path is so chosen that non-vertical parts are at great depths, where condition (*b*) can be expected to be approximately fulfilled.

Hydrostatic levelling is similar to oceanographic levelling, but has the advantage that the water in the tube comes to rest or oscillates about a position of equilibrium, so that condition (*b*) is necessarily fulfilled. The difference in geopotential between the two ends can, therefore, be computed from the equation above. Since the tube is filled with a liquid of known pressure-volume-temperature relationship, the necessary data are obtained by measuring the pressures $p_1$ and $p_2$ inside the ends, and the distributions of temperature and of approximate depth along the tube.

Hydrostatic levelling across the Straits of Florida would provide basic information concerning the Florida Current, the source of the Gulf Stream. The distance from Miami, Fla., to Cat Cay, B.W.I., is 82 km. ; the greatest intervening depth is about 900 m.

Not only can any two coastal points be joined by hydrostatic levelling, but also any coastal point can be joined with any point on the ocean surface if a tube holding a known liquid starts from the coastal point and has an open end on the bottom near the ocean point. In addition to the pressure $p_1$ at the coastal point and the atmospheric pressure $p_2$ at the ocean point, and to the temperature distribution along the tube, the distribution of specific volume below the ocean point must be measured. The path of integration lies from $p_1$ through the length of tube and vertically upward through the ocean water to $p_2$.

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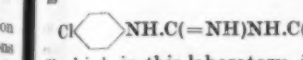
Jan. 22.

[1] Nørlund, N. E., Geodaetisk Instituts Skrifter, København, 3. raekke, **6**, 122 (1945).
[2] Nørlund, N. E., Geodaetisk Instituts Skrifter, København, 3. raekke, **7**, 84 (1946).

## Activation of Paludrine *in vitro*

PALUDRINE has recently been introduced into clinical medicine as a drug which is highly active against most species of malaria parasite; its formula is



Tonkin[1], in this laboratory, investigated its effect on the exoerythrocytic forms of *P. gallinaceum* grown in tissue culture, and found that it had no action upon the parasites in the highest concentrations (2–5 mgm. per litre) tolerated by the macrophages. Since this concentration is many times greater than that which is believed to be present in the plasma in human therapy (probably about 0·3 mgm. per litre) its inactivity was surprising; and the action of paludrine *in vitro* has been investigated further using *P. cynomolgi* of monkeys, and the exoerythrocytic forms of *P. gallinaceum* grown in tissue culture, as test organisms. *P. cynomolgi* was cultured *in vitro* at 37° C. by a modification of Bass and John's technique and, 41 hours later, smears were made and stained with Giemsa. The parasites found were classified according to the number of pieces of chromatin present, and the resulting differential counts are shown in the accompanying table. The figures indicate the percentage of parasites containing 1, 2-3, 4–5 pieces of chromatin, etc., respectively.

| | 1 | 2–3 | 4–5 | Greater than 5 | Degenerate | Gametocytes |
|---|---|---|---|---|---|---|
| Original blood | 90 | 10 | 0 | 0 | 0 | 0 |
| Control *A* | 0 | 6 | 31 | 49 | 10 | 4 |
| Paludrine added to serum *A* 2 mgm. per litre | 7 | 27 | 23 | 26 | 9 | 8 |
| 1 mgm. per litre | 7 | 25 | 26 | 31 | 4 | 7 |
| Paludrine serum (*B*) | 54 | 23 | 5 | 5 | 10 | 3 |
| " " 1/4 | 28 | 46 | 21 | 2 | 0 | 3 |
| " " 1/16 | 24 | 42 | 16 | 2 | 8 | 8 |
| " " 1/64 | 18 | 42 | 24 | 6 | 2 | 8 |

Monkey *A* was the donor which provided the parasites, and the serum for the controls and for dilution of serum *B*, etc. Serum *B* came from a monkey (weighing 3·4 kgm.) which had received two intramuscular injections, each of 50 mgm. paludrine acetate, 21 and 5 hours previously. Previous experiments had shown that the serum of this monkey had no injurious effects on malaria parasites obtained from monkey *A*.

The table shows that the parasites were originally present as forms with only one piece of chromatin; most of them were small rings. After 41 hours a large proportion in the control tube *A* had developed so that 49 per cent now possessed more than five pieces of chromatin (at complete schizogony there are sixteen pieces). Very similar development had occurred in the tubes to which paludrine had been added in relatively high concentration. In the tubes containing serum *B* from the monkey treated with paludrine, development of the parasite was inhibited to a considerable extent, so that 6 per cent or less of the parasites had reached the stage of more than five pieces of chromatin. (Other degenerative changes, which cannot easily be expressed in quantitative terms, were also present in the parasites of these tubes.) This inhibition was marked even in the tube which contained only 1 part of serum *B* diluted with 63 parts of *A*.

Similar results have been obtained in tissue cultures of the exoerythrocytic forms of *P. gallinaceum*. Serum from a fowl treated with paludrine possesses an antiplasmodial action which is absent when paludrine is added directly to the cultures. These findings are in agreement with those of Black[2], who reported that serum from a patient treated with paludrine arrested the development of trophozoites of *P. falciparum* when cultured *in vitro*; he did not examine the effect of adding paludrine directly to his cultures. It is concluded that probably paludrine does not itself possess antimalarial action, but that it is converted by the body into something which is active.

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London, N.W.3.
Feb. 3.

[1] Tonkin, I. M., *Brit. J. Pharm.*, **1**, 163 (1946).
[2] Black, R. H., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **40**, 163 (1946).

## An Œstrogenic Substance in Pollen-grains of Date Palm Tree *Phœnix dactylifera* L., Palmæ

THE term œstrogen or œstrin is now used to designate the whole group of œstrus-inducing substances irrespective of its constitution or origin.

The natural œstrogenic hormones are of wide occurrence, and although œstrogenic substances have been found in mineral sources yet none of naturally occurring œstrogenic hormones has been detected among them. A surprising discovery was that œstrin occurs in the vegetable kingdom. Butenandt and Jacobi[1] succeeded in isolating pure œstrone from a palm kernel extract, and Skarzynski[2] obtained from female willow flowers a crystallizate of pure œstriol, the hormone hydrate. The substances isolated from the plants produced a typical œstrus response in ovariectomized rats.

We have found an œstrogenic substance in pollen-grains of the palm plant. The active part is found in the non-saponified fraction of the oil extracted from the dry pollens. A water-soluble form of this active part was made according to Marrian's method and tested biologically. A batch of eleven ovariectomized rats weighing 140–160 gm. were divided into three groups.

*Group* 1. Three rats received no supplement and used as negative controls.

*Group* 2. Three rats injected with pure œstradiol dipropionate and used as positive controls.

*Group* 3. Five rats injected with the water-soluble form obtained from the palm pollen-grains in four doses over a period of twenty-four hours.

All groups were kept under observation and showed no cycles during a preparatory period of two weeks, after which both groups 2 and 3, which were injected with the active material at the same time, showed simultaneously identical complete cornification of the vaginal smear twenty-four hours after the last injection.

This proved the occurrence of a biologically active œstrogenic substance in the pollen-grains of the palm plant.

A spectroscopic examination of this fraction dissolved in absolute alcohol showed an absorption band in the ultra-violet region near 282 mμ, as compared with the 280 mμ of œstrone.

On addition of concentrated sulphuric acid to a chloroformic solution of this fraction, an orange coloration is observed which is changed to a red solution on adding a few drops of water and heating in a boiling water bath (Kober's test for œstrone[3]). The active part also gives a red coloration with Marrian's phenol-sulphonic acid reagent[4] specific for œstrone.

This problem was suggested by H. E. Dr. S. Azmy Pasha, professor of medicine. Further work is in progress to identify and to isolate this biologically active œstrogenic material.

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M. HASSAN ABOU EL WAFA

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Cairo. Dec. 28.

[1] Butenandt and Jacobi, *Z. physiol. Chem.*, **218**, 104 (1933).
[2] Skarzynski, Bull. Int. Acad. Pol., Class, Sec. Sci. Math. Nat., B 11, 347 (*Chem. Abst.*, **28**, 4755; 1934).
[3] Kober, S., *Biochem. Z.*, **239**, 209 (1931).
[4] Cohen and Marrian, *Biochem. J.*, **28**, 1603 (1934).
[5] Callow, R., *Biochem. J.*, **30**, 906 (1936).

## Mauthner's Cells in the Larvæ of Anuran Amphibia

THE cells of Mauthner occur in the medulla oblongata of many teleost fishes, Dipnoi and urodele Amphibia, where they have been widely studied. On the other hand, their occurrence in the larvæ of anuran Amphibia has been disputed for many years, and to judge from the literature most attempts to find them have failed. Szepsenwol[1] claims to have found them in the larvæ of *Rana fusca* and *Bombinator pachypus*; but his account, unfortunately published without illustration, does not appear to have received general recognition.

With the aid of a new silver-staining method, an account of which is now in the press, I have recently obtained clear evidence for the regular occurrence of a single pair of Mauthner's cells in 22 mm. larvæ of *R. fusca*. With regard to the size and position of these cells, and the distribution of their dendritic processes, I am in agreement with the account given by Szepsenwol. The cells are best seen in thick (20–25 μ) transverse sections of the medulla, near the entry of the auditory nerve roots.

My observations on that part of the axon process which is usually described as 'Mauthner's fibre' differ considerably from Szepsenwol's description. The latter states that, in *R. fusca*, Mauthner's fibres are single processes. Against this, I have found that, before decussating, each fibre divides into two similar and thinner fibres. Each of these decussates separately with its fellow from the opposite side of the medulla, and becomes contralateral. The two decussations are equidistant from Mauthner's cells and occur one above the other. Posteriorly, the two contralateral fibres formed by each Mauthner's cell run beside the fasciculus longitudinalis medialis to the tail. In 22 mm. larvæ the Mauthner fibres are about twice as thick as the fibres of the fasciculus longitudinalis medialis, and have a more marked affinity for silver.

During larval life up to the 18–22 mm. stage (approximately), the growth of the Mauthner system is accompanied by the development of Rohon-Beard sensory cells, arranged as a dorsally situated column along the spinal cord. In later larval life, the growth of both these specifically larval components of the central nervous system is arrested. The Rohon-Beard cells rapidly undergo degeneration, while the Mauthner system persists without any further considerable differentiation.

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[1] Szepsenwol, J., *C.R. Soc. Biol., Paris*, **118**, 44 (1935).

## Ethical Aspects of the Development of Atomic Energy

BOTH the letter from Lionel Curtis in *Nature* of January 25 and the editorial article in the issue of December 21 appeal for "the fact-finding method of science" to be brought "into the political sphere"; but both, it seems to me, ignore the most significant fact in the world situation.

If it were true, in any immediate sense at least, that "The future of humanity depends on the three great Powers, not less than others, placing themselves strictly under the judgment and the surveillance of the rest of the world", then there would be no future for humanity. For such a dictum ignores the fact that one part of the world has, or is developing, a planned economy which involves great restriction or even abolition of the freedom of 'private enterprise', while the other part declares such freedom to be the essential core of civilization. There are intermediate positions, of course, but the two extremes, represented by the U.S.A. and the U.S.S.R., will not submit to each other's judgment in these matters.

A "strong international democracy" in such circumstances is impossible, and those who declare it to be essential merely make the side which would be in a minority, if such a democracy could be brought into existence, feel that the real intention is to impose on them an economic system they abhor. It is perhaps significant for a scientific investigator that all such declarations do, in fact, come from the side which would at present be in a majority.

I think such an international democracy will come into existence when the present polarization of social structure and ideas has ceased to exist. But that will not be in time to solve our present problems. What, then, can be done?

The essential thing is to see that the conflict which undoubtedly exists between the two parts of the world is resolved by friendly competition and not by armed force. At present it is only too obvious that each side suspects the other of attempting to achieve its domination by armed force. The great task facing us is to dispel that suspicion and create the conditions for peaceful rivalry between the two systems; to see which can, in the long run, give the common man more of the things, material and spiritual, which he desires.

What is required is a declaration by all the Powers that they will not use, make or keep a stock of atomic bombs or other weapons of mass destruction. While this is obviously insufficient by itself, it would help to allay suspicions and pave the way for general disarmament, in which the question of control of atomic energy would take its logical place along with the general control of disarmament.

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# RELEASE OF INFORMATION ON ATOMIC ENERGY

IT is well known that the scientific work leading to the design of an atomic bomb was carried out under conditions of the strictest secrecy, and even fundamental scientific information obtained in this connexion was jealously guarded. It is natural that under post-war conditions much of this information can be released, but there are obvious difficulties in publishing it in the normal way.

The work was done as a joint project, shared by the American, British and Canadian Governments. Each country is considering its material independently, though on an internationally agreed basis as to what may and what may not be released. Most of the material is in the form of hastily written reports, and there is a reluctance on the part of authors to go back to this old material and to rewrite it in a form suitable for publication. Moreover, in many cases there would be independent publication of similar material from the United States or Canada. In view, too, of the continuing paper shortage, journals would find difficulty in publishing all the material, even if it were offered to them.

It has consequently been decided that where British information is declassified, copies of the reports shall be deposited in the Science Library at South Kensington, London, and the titles, of which a list follows, announced to the scientific public. So far as supplies permit, copies will be lent to responsible workers if they apply to the Technical Records Section, Department of Atomic Energy, Shell Mex House, Strand, London, W.C.2.

LIST OF BRITISH DECLASSIFIED REPORTS ON ATOMIC ENERGY

| Title | Authors | Date |
|---|---|---|
| Investigation of the Delayed Neutron Emission from Fission Products, using a Modulated Source of Primary Neutrons | Feather, N. | August 1941 |
| Streamline Flow through a Pipe of Rectangular Cross-section | Peierls, R. | November 1941 |
| On the Possibility of a Slow-Neutron Chain Reaction | Frisch, O. R. | November 1941 (prior) |
| Separation of a Mixture of Three Components | Peierls, R. | November 1941 (approx.) |
| On the Counting of Neutrons using a Thick Layer of Hydrogen-rich Material and a 'Proportional' Counter | Feather, N. | March 1942 |
| Directional Correlation in Fission Processes: Calculations relative to Possible Experiments | Feather, N. | April 1942 |
| The Motion in a Self-fractionating Centrifuge | Dirac, P. A. M. | May 1942 |
| Isotope Analysis of Uranium Samples by means of their $\alpha$-Ray Groups | Frisch, O. R. | June 1942 (prior) |
| Absorption Measurements on the Radiations from $^{235}U$ and $^{238}X$ | Feather, N. | July 1942 |
| Determination of Number of Neutrons emitted from a Source | Rotblat, J. | October 1942–January 1943 |
| Note on the Theory of Supersonic Diffusers | Friedlander, F. | November 1942 (approx.) |
| Flow in the Gap between the Impeller and Diffuser | Friedlander, F. | January 1943 (approx.) |
| Energy Distribution of Fission Neutrons | Peierls, R. | November 1942 (approx.) |
| On a Modification of an Experiment suggested by Holt, Peierls and Frisch | Feather, N. | November 1942 |
| The Blast Wave due to an Intense Explosion | Kynch, G. J. | December 1942 (approx.) |
| The Equation of State of Air at High Temperature | Fuchs, K.<br>Kynch, G. J.<br>Peierls, R. | "<br>" |
| Determination of the Total Neutron Collision Cross-Section for Hydrogen and Carbon | Bretscher, E.<br>Murrell, E. B. M. | January 1943 |
| The Ratio between Absorption Cross-Sections of B and H | Halban, H.<br>Fenning, F.<br>Seligman, H. | January 1943 |
| Fluorinated Lubricants | Park, J. R. | January 1943 |
| Some Theoretical Results on the Flow in Supersonic Diffusers | Friedlander, F. | January 1943 (approx.) |
| Use of a Small Boron Chamber for Measuring Absolute Yields of Neutron Sources | Kowarski, L.<br>Bauer, S. G.<br>Freundlich, H.<br>May, A. N.<br>Seligman, H. | January 1943 |
| On a Shock Wave Problem Arising in the Theory of Supersonic Diffusers | Friedlander, F. | January 1943 |
| Density Distribution near a Point Source | Peierls, R.<br>Davison, B. | February 1943 |
| Light Absorption by Two Black Hemispheres | Frisch, O. R.<br>Peierls, R. | February, 1943 |
| Regularities in Successive $\beta$-Disintegrations | Feather, N. | April 1943 |
| Boundary Conditions in the "Modified Diffusion Theory" for the Neutron Density Distribution in Presence of a Container (incomplete) | Davison, B. | May 1943 |
| The Blast Wave due to an Intense Explosion | Howlett, J. | March 1944<br>April 1943 |
| On the Counting of the $\alpha$-Particles emitted by "Semi-Thick" Layers of Uranium: Effect of the Variation of Stopping Power with Velocity | Feather, N. | June 1943 |
| $\alpha$-Particle Group Analysis using a Parallel-Plate Ionization Chamber: Effect of Variation on Stopping Power with Velocity | Feather, N. | June 1943 |
| The Estimation of Deuterium in Water by the Temperature-Float Method | Bell, W. A. | July 1943 |
| On the Flow of Gases through Expanding Pipes | Friedlander, F. | *c.* July 1943 |
| Part I: Approximate Rate of Neutron Multiplication for a Solid of Arbitrary Shape and Uniform Density | Dirac, P. A. M. | August 1943 |
| Part II: Application to the Oblate Spheroid Hemisphere and Oblate Hemispheroid | Dirac, P. A. M.<br>Fuchs, K.<br>Peierls, R.<br>Preston, P. | " |
| A Comparison of the Approximate Methods of Calculating the Critical Size of a Sphere | Wilson, A. H. | August 1943 |
| The Loss of Energy by Fission Fragments at High Temperatures | Kynch, G. J. | July 1943 |
| Physical Properties of Some $\phi$-Compounds* | Haworth, W. N. | August 1943 |
| Reduction in Neutron Density caused by an Absorbing Disk | Skyrme, T. H. R. | September 1943 |
| Detector Response to Neutrons Slowed Down in Media Containing Cadmium | Broda, E.<br>Hereward, H.<br>Kowarski, L. | September 1943 |
| Escape of Energy from a Cylindrical Ionisation Chamber | Skyrme, T. H. R. | October 1943 |
| The Critical Radius and the Time Constant of a Sphere Embedded in a Spherical Scattering Container | Davison, B.<br>Fuchs, K. | November 1943 (prior) |
| Critical Radius for a Hemisphere with a One-Sided Infinite Container | Davison, B. | November 1943 |
| Differential Diffusion through a Capillary | Kynch, G. J. | December 1943 |
| Measurement of the Concentration of U235 in a Sample of Uranium Oxide enriched in this Isotope | Kinsey, B. B.<br>Cohen, S. J. | December 1943 |
| Barium 139 as Fission Indicator | Broda, E. | December 1943 |
| Szilard–Chalmers Effect in Permanganate Solutions | Broda, E. | January 1944 |
| A Neutron Standard | Bretscher, E.<br>Cook, G. B.<br>Martin, G. R. | January 1944 |
| Determination of the Number of Neutrons Emitted by a Radium–Beryllium Source | Bretscher, E.<br>French, A. P.<br>Martin, G. R.<br>Poole, M. J. | *c.* February 1944 |

* Fluorinated compounds.

| Title | Authors | Date |
|---|---|---|
| The Effect of Small Departures from the Spherical Shape upon the Critical Size and Time Constant of a Sphere | Wilson, A. H. | March 1944 |
| Alpha-Ray Analysis of *X*-Isotopes*. Part I. Apparatus | Clark, F. L.<br>Spencer-Palmer, H.<br>Woodward, R. N. | May 1944 |
| Tests Concerning the Reproducibility of the RaBeF$_4$ Neutron Standard and its Calibration as a Source of Neutrons | Wilkinson, D. H. | June 1944 |
| The Critical Size and Time Constant of a Spheroid | Fairbrother, H. | June 1944 |
| The Energy Spectrum of the Neutrons from the Lithium (*p*,*n*) Reaction | Kinsey, B. B.<br>Cohen, S. G. | June 1944 |
| Critical Radius of a Hemisphere Completely Surrounded by a Container | Preston, P. D.<br>Davison, B. | July 1944 |
| The Effect of Anisotropic Scattering on the Multiplication in a Sphere | Wilson, A. H. | July 1944 |
| Note on the Investigation of Spatial Asymmetry in Fast Neutron Fission, using a Double Ionisation Chamber and Pulse Analyser, and its Possible Bearing on the Problem of Large Capture Cross-Sections at High Energies | Feather, N. | July, 1944 |
| Iodine 131 and 133 as Fission Indicators | Broda, E. | September 1944 |
| On a Possible Method of Investigating the Back-Scattering of $\alpha$-Particles under Conditions of "50 per cent Geometry" | Feather, N. | September 1944 |
| On the Distribution of Pulse Sizes in a Parallel-Plate Ionization Chamber containing a Thick Layer of Hydrogen-Rich Material Irradiated with a Parallel Beam of Neutrons | Feather, N. | September 1944 |
| On the Distribution of Pulse Sizes in a Parallel Plate Ionisation Chamber containing a Thick Layer of Hydrogen-Rich Material Irradiated with Neutrons (II): Effect of Oblique Incidence | Feather, N. | October 1944 |
| A Rapid Colorimetric Method for the Determination of *T* in Solutions of $TO_2F_2+HF$, by means of Hydrogen Peroxide† | Smales, A. A. | November 1944 |
| Chance Coincidences between Non-Random Sequences, with particular reference to Experiments using a Cyclotron Source | Feather, N. | *c.* January 1945 |
| X-Ray Powder Patterns of some *X* Metal‡ Compounds | Peiser, H. S.<br>Alcock, T. C. | March 1945 |
| Upper Limits of the Fission Cross-Sections of Lead and Bismuth for Li-D Neutrons | Broda, E.<br>Wright, P. K. | April 1945 |
| The Range/Energy Relation for $\alpha$-Particles of 0–5·3 MeV. in Ethylene and Polythene | Wilkinson, D. H. | May 1945 |
| A Photographic Plate Study of Neutrons from the D-D Reaction | Livesey, D. L.<br>Wilkinson, D. H. | May 1945 |
| Differential Diffusion Through a Capillary (Part I. Mathematical) | Kynch, G. J. | *c.* June 1945 |
| The Assignment of the Slow-Neutron-Produced Activities of Thallium and the Dual Disintegration of Radium E | Broda, E.<br>Feather, N. | June 1945 |
| Preparation of a Strong Thin Polonium Source and Preliminary Experiments on the Yield of ($\alpha$,*n*) Reactions | Broda, E.<br>Wright, P. K. | July 1945 |
| Differential Diffusion through a Capillary, Part II | Kynch, G. J. | *c.* August 1945 |
| Measurement of a Flux of Fast Neutrons with a Counting Pressure - Ionization Chamber | Allen, K. W. | August 1946 |
| The Application of the Photographic Plate to the Quantitative Determination of Activities by Track Counts | Broda, E. | August 1946 |
| The Permeability of Metals to Argon and Helium | British Non-Ferrous Metals Research Association | October 1946 |

* Uranium isotopes.

† *T* = uranium.

‡ Uranium.

# SCIENTIFIC RESEARCH IN THE PACIFIC AREA

THE *Proceedings* of the Pacific Science Conference of the National Research Council, held at Washington, D.C., June 6–8, 1946, and now published as Bulletin No. 114 of the National Research Council (Washington, D.C.: National Academy of Sciences), includes reports of the opening addresses and of the various sessions, the specific and general recommendations of the Conference, the proposed organisation of the Pacific Science Survey and the recommendations relating to international co-operation.

The objectives of the Conference were to form an effective organisation of American men of science interested in the Pacific, to encourage and assist scientific research and activities in that area, and to further international co-operation along these lines. These objectives were detailed more specifically by Dr. Douglas L. Oliver at the opening session, and the permanent organisation which the Conference recommended the National Research Council should establish under some such name as the Pacific Science Survey contemplates six divisions, for anthropological sciences (including human geography), earth sciences, oceanography and meteorology, plant sciences, public health and medicine, and zoological sciences, respectively, each represented by a committee within the appropriate division of the National Research Council, the chairmen of these committees, with three others, constituting the Pacific Science Board. A co-ordinated programme of scientific research for the Pacific Islands, under American or foreign administration, has been formulated, and recommendations are detailed in the report under each of the divisional heads given above.

The pamphlet also includes a number of general recommendations regarding the release of materials and scientific information, the conservation of flora and fauna, and the use of insecticides, herbicides, etc., which might disturb the biological balance, the interchange of information on the physiology, biochemistry and biophysics of plants of importance in the Pacific area; and the establishment of base stations for scientific research in Hawaii, Guam and the Galapagos Islands, as well as floating stations, advance base stations for both marine and terrestrial research on various types of islands and at the extremes of environmental conditions and liaison stations in the Solomon Islands, Australian and Dutch New Guinea, French Oceania, Indonesia, the Philippines and the Galapagos. A survey of the state of our knowledge in the various fields of science in the Pacific, including a bibliography of the basic contributions, and documentation centres at Washington and Honolulu are also recommended.

Specific recommendations pertaining to international co-operation relate to the establishment of visitors' facilities at the principal centres, collaboration with interested institutions and individuals, American and foreign, in the preparation of a series of regional Floras, and encouragement of field-work in areas for which the data are inadequate. The establishment by the Government of the Netherland Indies of a scientific research station at Hollandia, Dutch New Guinea, is also recommended. Other matters discussed are the formation of international committees for the correlation and standardization of nomenclature and methods of measurement,

extension of the survey of the Algæ and algal resources of Philippine and Indonesian waters to cover the Pacific, and the establishment of a scientific centre in the Philippines, supported by private funds.

## FREE-PISTON COMPRESSOR-ENGINES

THE paper by H. O. Farmer on "Free-Piston Compressor-Engines", read before the Institution of Mechanical Engineers on December 6, must have been for many their first introduction to the subject, as this type of engine has received little publicity and has only just reached the production stage.

The free-piston compressor-engine, in its production form, is a reciprocating air compressor driven by a reciprocating two-stroke compression-ignition (or Diesel) engine. The outstanding feature is that neither the engine nor the compressor has the conventional rotating crankshaft; instead, the engine and compressor cylinders are arranged in line and the pistons are coupled directly. A normal engine has a flywheel which supplies the energy for the compression stroke; but in the free-piston engine, which has no flywheel, energy is supplied by the compressed air remaining in the compressor cylinder clearance space. This action is assisted in most free-piston engines by a separate 'cushion' cylinder with a closed end.

In order to improve the balance, there is usually a piston at each end of the engine cylinder, one being coupled directly to the compressor piston and the other to the 'cushion' piston; these two moving systems are coupled by a light linkage so that their displacements are equal and opposite. The underside of the compressor piston is used to pump scavenging air for the engine cylinder. This arrangement has all the very attractive features of the opposed-piston, two-stroke, supercharged, compression-ignition engine without the complication and expense of the connecting rods and rotating parts associated with conventional designs.

The amount of fuel injected is varied automatically by a governor so as to keep the output air pressure constant; the effect of varying the air demand being to change the stroke of the plant (the stroke is not fixed as in a normal plant). The frequency of the cycles remains nearly constant, and is 1,000 cycles per minute in one case quoted in the paper.

Starting is accomplished by bringing the engine pistons together suddenly. In small engines this is done by a spring, previously compressed manually through a handle and gearing; in larger engines a charge of compressed air is admitted to the 'cushion' cylinder. Another interesting detail is the method of driving rotating accessories such as the cooling fan and the water pump; the main reciprocating parts drive a plunger-type oil pump; this oil then drives a gear-type oil motor which provides the small power required.

A possibility which is being actively investigated is the use of a free-piston compressor-engine, instead of the usual rotary air compressor, in conjunction with a gas turbine for power purposes. The whole of the air pumped by the compressor cylinder is fed to the engine cylinder for scavenging and supercharging, and the hot exhaust gas, at comparatively high pressure, passes through a gas turbine. It is claimed that the very high overall efficiency of 41 per cent is obtainable.

Free-piston compressor-engines were largely developed by Pescara, who started work on them in France in 1922. In Great Britain their development was encouraged by the Services; the first engines were ordered for the Navy and later ones for the Army.

## TREPHOCYTES AND TREPHOCYTOSIS

DR. LIEBMAN'S monograph, "On Trephocytes and Trephocytosis; a Study on the Role of Leucocytes in Nutrition and Growth" (*Growth*, **10**, 291; 1946), concerns a neglected field of invertebrate hæmatology, and combines a comprehensive review of the literature with a record of his own extensive studies. Attention is focused on leucocytic elements that contain inclusion bodies (granules, spherules and pigment), but which, according to the evidence, have no phagocytic function. The author advances a well-substantiated view that the inclusion bodies are elaborated inside these cells, which he calls 'trephocytes', and that they are discharged and utilized as nutrient material in regions of increased metabolic activity. Hence the concept of trephocytosis, which is thought to be the main function of these cells, as opposed to phagocytosis, which, in the author's opinion, may well be the main task of hyaline 'lymphoidocytes'. On the comparative side, a parallel is drawn between the trephocytes of invertebrates and the mast cells of vertebrates.

The attitude of the author is characterized by a justified reluctance to apply, without reservation, the teleological line of thought imposed by mammalian 'defence' physiology and, consequently, a caution in attributing phagocytic properties to elements which do not seem to possess any.

Of particular interest are the author's current studies in Tunicates, and especially his observations made in Sipunculids and Polychætes, where some blood cells reveal intermediate characteristics between leucocytes with inclusions and erythrocytes. A more detailed account of this work may well prove of great value for comparative hæmatology.

## FORTHCOMING EVENTS

### Monday, March 31

PALÆONTOGRAPHICAL SOCIETY (in the Geological Survey Museum, Exhibition Road, London, S.W.7), at 11 a.m.—Centenary Meeting; Prof. H. L. Hawkins, F.R.S.: Commemorative address: at 2.30 p.m.—Mr. C. P. Chatwin: "The Story of Fossils".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Developments in Fractional Horse-Power Motors" (to be opened by Mr. A. N. D. Kerr).

### Tuesday, April 1

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—A representative of the Mond Nickel Co., Ltd.: "Isothermal Transformations".

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2).—Annual General Meeting.

### Wednesday, April 2

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. N. Sparkes: "Some Defects in Concrete Roads—Causes and Remedies".

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (in Room 104, College of Art and Technology, Leicester), at 7 p.m.—Dr. G. L. Royer: "Studies on Wool Dyeing—Comparison of Methods for Applying Chrome Dyes".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER OR LECTURER IN SOILS AND MANURES, and an ASSISTANT LECTURER IN BIOCHEMISTRY, at the Massey Agricultural College, Palmerston North—The High Commissioner for New Zealand, 115 Strand, London, W.C.2 (April 9).

SENIOR LECTURER and a LECTURER IN THE DEPARTMENT OF ANATOMY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (April 15).

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

British Standard 1335: 1946. Air-Depolarised Primary Cells. Pp. 16. (London: British Standards Institution, 1946.) 2*s*. net. [312

Department of Scientific and Industrial Research: Road Research. Special Report No. 3: Roadstone—Geological Aspects and Physical Tests. By Dr. J. Phemister, E. M. Guppy, A. H. D. Markwick and F. A. Shergold. Pp. iv + 42. (London: H.M. Stationery Office, 1946.) 9*d*. net. [312

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Thirty-ninth Annual Report, 1945–46. Pp. 38. (Cardiff: National Museum of Wales, 1946.) [412

Physical Society. Report on Defective Colour Vision in Industry. By a Committee of the Colour Group. Pp. 52. (London: Physical Society, 1946.) 3*s*. 6*d*. net. [412

Department of Scientific and Industrial Research: Forest Products Research. Bulletin No. 20: Requirements and Properties of Adhesives for Wood. By R. A. G. Knight. Pp. vi + 26. (London: H.M. Stationery Office, 1946.) 6*d*. net. [512

Scientific Film Association. The Classification, Appraisal and Grading of Scientific Films. Pp. 18. (London: Scientific Film Association, 1946.) 2*s*. 6*d*. [512

Reports on Fuel Economy since 1939—British National Committee. Pp. 52. (London: World Power Conference, 1946.) 1*s*. 6*d*. net. [912

Imperial Institute: Mineral Resources Department. Nigeria: Geology and Mineral Resources. By Dr. F. Dixey. (Reprinted from the *Bulletin of the Imperial Institute*, Vol. 43, No. 4, October–December 1945.) Pp. 18 + 4 plates. (London: Imperial Institute, 1946.) 1*s*. net. [912

Signposts to Better Filtration: to Assist Chemists in the Selection of Filter Papers. Prepared by A. McM. Taylor. Pp. 20. (Maidstone: J. Barcham Green, Ltd., 1946.) 2*s*. 6*d*. net. [912

British Society of Animal Production. Report of Proceedings, Fifth Meeting, 26th February 1946, General Topic: Breeding Methods in Livestock Improvement; Open Meeting, 27th February 1946, General Topic: Artificial Insemination. Pp. 94. (Aberystwyth: British Society of Animal Production, University College of Wales, 1946.) 3*s*. [912

Hull Bulletins of Marine Ecology. Vol. 3, No. 18: Investigations into the Food of the Cod (*Gadus callarius* L.) off Bear Islands, and of the Cod and Haddock (*G. aeglefinus* L.) off Iceland and the Murman Coast. By W. W. Brown and Dr. C. Cheng. Pp. 35–72. (Hull: University College, 1946.) 4*s*. [912

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 16, No. 2, September. Compiled by Agnes Elisabeth Glennie, assisted by Diana Margaret Studdert Holmes. Pp. iv + 75–162. (London: H.M. Stationery Office, 1946.) 4*s*. 6*d*. net. [912

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 17: The Genus Primula, Sections Obconica, Sinenses, Reinii, Pinnatae, Malacoides, Bullatae, Carolinella, Grandis and Denticulata. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 415–478. (Edinburgh and London: Oliver and Boyd, 1946.) 16*s*. [1212

German Educational Reconstruction. No. 5: Public Libraries in Germany. By Heinz Schurer. Pp. 24. (London: German Educational Reconstruction, 1946.) 1*s*. 6*d*. net. [1212

Department of Scientific and Industrial Research: Forest Products Research Laboratory. Leaflet No. 40: The Preparation of Wood for Microscopic Examination. Pp. 8. (Princes Risborough: Forest Products Research Laboratory, 1946.) Free. [1212

Colonial Office. Memorandum on Colonial Mining Policy. (Colonial No. 206.) Pp. 10. (London: H.M. Stationery Office, 1946.) 2*d*. net. [1212

University of Leeds. Report of the Librarian for the Session 1945–46. Pp. 8. (Leeds: The University, 1946.) [1612

Post-War Building Studies. No. 20: Fire Grading of Buildings. Part 1: General Principles and Structural Precautions. By a Joint Committee of the Building Research Board of the Department of Scientific Research and of the Fire Offices' Committee. (Published for the Ministry of Works.) Pp. 116. (London: H.M. Stationery Office, 1946.) 1*s*. 6*d*. net. [1612

British Chemicals and their Manufacturers: the Official Directory of the Association of British Chemical Manufacturers, Inc. Pp. 121. (London: Association of British Chemical Manufacturers, 1946.) Free. [1612

British Commonwealth Scientific Official Conference, London 1946. Report of Proceedings. (Cmd. 6970.) Pp. 73. (London: H.M. Stationery Office, 1946.) 1*s*. 3*d*. net. [1712

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Thirty-first Annual Report, 1945. Pp. 98. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd., 1946.) [1812

Medical Research Council. Special Report Series, No. 258: The Preservation of Proteins by Drying, with Special Reference to the Production of Dried Human Serum and Plasma for Transfusion. By Dr. R. I. N. Greaves. Pp. v + 54 + 20 plates. (London: H.M. Stationery Office, 1946.) 2*s*. net. [1912

### Other Countries

Bergens Museums Årbok: Naturvidenskapelig rekke. 1938, Hefte 2, Nr. 5–11. Pp. 122 + 2 plates. 1939–40, Hefte 1, Nr. 1–6. Pp. 277 + 34 plates. 1939–40, Hefte 2, Nr. 7–8. Pp. 215 + 4 plates. 1941, Hefte 1, Nr. 1–5. Pp. 192 + 3 plates. 1941, Hefte 2, Nr. 6. Pp. 236. 1941, Hefte 3, Nr. 7–11. Pp. 202 + 1 plate. 1942, Hefte 1, Nr. 1–5. Pp. 131. 1942, Hefte 2, Nr. 6–9. Pp. 262 + 8 plates. 1942, Hefte 1, Nr. 1–7. Pp. 192 + 6 plates. 1943, Hefte 2, Nr. 8–11. Pp. 186 + 10 plates. (Bergen: A/s John Griegs Boktryckkeri, 1940–1944.) [2811

Bergens Museums. Skrifter Nr. 20: Geology of the Bergen Arc System. By Carl Fred. Kolderup and Niels-Henr. Kolderup. Pp. 137 + 14 plates. 20 kr. Skrifter Nr. 22: Sikilsdalen og Norges fjellbeiter, en plantesosiologisk monografi. Av Rolf Nordhagen. Pp. xvi + 607. 30 kr. (Bergen: A/s John Griegs Boktryckkeri, 1940–1943.) [2811

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1940. Pp. 35. 2*s*. Annual Report of the Geological Survey Department for the Year ended 31st December 1941. Pp. 34. 2*s*. (Entebbe: Geological Survey Department, 1941–42.) [312

Indian Forest Leaflet. No. 71: A Note on the Species of South Indian Watties. By M. V. Edwards. Pp. ii + 9. 4 annas. No. 73: The Vegetable Tanning Materials of India, Part 2, Avaram (*Cassia auriculata* Linn.) By M. V. Edwards. Pp. ii + 21. 8 annas. No. 75: The Vegetable Tanning Materials of India, Part 4, Myrobalan (*Terminalia chebula* Retz.) By M. V. Edwards. Pp. ii + 19. 8 annas. (Dehra Dunn: Forest Research Institute, 1945.) [912

Crohamhurst Observatory. Observatory Paper No. 12: The Elements of Crohamhurst, 1892-1942. By Inigo Jones. Pp. 19. (Crohamhurst: Crohamhurst Observatory, 1942.) [912

U.S. Department of the Interior: Geological Survey. Bulletin 945-G: Chromite Deposits of the North Elder Creek Area, Tehama County, California. By G. A. Rynearson. (Strategic Minerals Investigations, 1944.) Pp. iv + 191–210 + plates 65–70, n.p. Bulletin 947-B: Molybdenite Investigations in Southeastern Alaska. By W. S. Twenhofel, G. D. Robinson and H. R. Gault. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iv + 7–38 + 8 plates, n.p. Bulletin 947-C: Nickel Investigations in Southeastern Alaska. By George C. Kennedy and Matt S. Walton, Jr. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iv + 39–64 + plates 9–18. 15 cents. Bulletin 947-D: Geology and Associated Mineral Deposits of some Ultrabasic Rock Bodies in Southeastern Alaska. By George C. Kennedy and Matt S. Walton, Jr. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 65–84 + plates 19–22. 10 cents. Bulletin 947-E: Copper Bullion Claims, Rua Cove, Knight Island, Alaska. By Karl Stefansson and Robert M. Moxham. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 85–92 + plates 23–25. 10 cents. Bulletin 947-F: Copper Deposits of the Nizina District, Alaska. By Don J. Miller. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 93–120 + plates 26–29. 15 cents. Bulletin 947-G: Copper Deposits of the Kotsina-Kuskulana District, Alaska. By Ralph E. Van Alstine and Robert F. Black. (Mineral Resources of Alaska, 1943 and 1944.) Pp. ii + 121–142 + plates 30–32. 15 cents. Bulletin 950: Contributions to Geochemistry, 1942–45. Short Papers by R. C. Wells and others. Pp. vi + 162 + 5 plates. 40 cents. (Washington, D.C.: Government Printing Office, 1946.) [912

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 943: Geology and Ground-Water Resources of Scotts Bluff County, Nebraska. By L. K. Wenzel, R. C. Cady and H. A. Waite. Pp. vi + 150 + 12 plates. 25 cents. Water-Supply Paper 985: Surface Water Supply of Hawaii, July 1, 1942, to June 30, 1943. Pp. iv + 134. 30 cents. Water-Supply Paper 988: Water Levels and Artesian Pressure in Observation Wells in the United States in 1943, Part 3, North-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 352. 55 cents. Water-Supply Paper 989: Water Levels and Artesian Pressure in Observation Wells in the United States in 1943, Part 4, South-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 194. 35 cents. (Washington, D.C.: Government Printing Office, 1946.) [912

Council of Scientific and Industrial Research. Revised Scheme for the Establishment of the National Metallurgical Laboratory. Pp. 20 + 6 plates. (Delhi: Council for Scientific and Industrial Research, 1946.) [912

Twenty-ninth Annual Report of the National Research Council of Canada, 1945–1946. (N.R.C. No. 1411.) Pp. 65. (Ottawa: National Research Council, 1946.) [912

Bulletin of the American Museum of Natural History. Vol. 87, Article 3: Contributions to the Paleontology of the Lebanon Mountains, Republic of Lebanon, Part 3, The Pelecypod Fauna of the 'Olive Locality' (Aptian) at Abeih. By Prof. Harold E. Vokes. Pp. 139–216 + 10 plates. Vol. 87, Article 4: *Sebecus*, Representative of a Peculiar Suborder of Fossil Crocodilia from Patagonia. By Edwin Harris Colbert. (Publications of the Scarritt Expeditions, No. 35.) Pp. 217–270 + plates 11–16. (New York: American Museum of Natural History, 1946.) [1212

Publications of the Astronomical Institute of the University of Amsterdam. No. 6: A Photometric Study of some Stellar Spectra (δ Cephei, θ Cygni, π Cephei, δ Equulei), Part 2, Discussion of Results. By A. Pannekoek and G. B. van Albada. Pp. iii + 116. (Amsterdam: The University, 1946.) [1212